STATE OF ILLINOIS
ADLAI E. STEVENSON, *Governor*
DEPARTMENT OF REGISTRATION AND EDUCATION
NOBLE J. PUFFER, *Director*

DIVISION OF THE
STATE GEOLOGICAL SURVEY
M. M. LEIGHTON, *Chief*
URBANA

BULLETIN NO. 73

BEDROCK TOPOGRAPHY OF ILLINOIS

BY

LELAND HORBERG

Property of
Geology Department
Emory University

PRINTED BY AUTHORITY OF THE STATE OF ILLINOIS

URBANA, ILLINOIS

1950

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MANUSCRIPT COMPLETED MARCH, 1946

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This report is a contribution of the Subsurface Geology Division.

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BEDROCK TOPOGRAPHY OF ILLINOIS

BY

LELAND HORBERG

CHAPTER 1—INTRODUCTION

PURPOSE OF THE REPORT

Study of groundwater conditions within the glacial deposits of Illinois over the past twenty years has emphasized the fact that the most important water-bearing glacial sands and gravels are localized along major bedrock valleys. These valleys at various times during the glacial period functioned as drainageways for the escape of waters from the melting ice fronts and received large quantities of glacial outwash. Some of the valleys, such as the Mississippi and Lower Illinois, are in most places only partially filled with glacial deposits; other valleys equally large are completely buried. The present study is intended primarily as an aid in locating these valleys, evaluating their aquifers, and determining general groundwater conditions throughout the glaciated area.

The bedrock-surface contour map (pl. 1) should also be of interest to engineers, geophysicists, and others who are variously concerned with a general appraisal of overburden on bedrock, "cut-outs" in coal beds, foundation conditions for dams and massive structures, construction of canals and aqueducts, drilling operations, geophysical surveys, and the like.

SIGNIFICANCE OF BEDROCK TOPOGRAPHY

The bedrock topography is of general geological interest because: (1) It constitutes the basis for interpreting the preglacial erosional history of the State; (2) it provides information that aids in deciphering the complex drainage changes brought about by the glacial invasions; (3) it helped influence the direction of ice movement and consequently the distribution of various drift-sheets; (4) it controls the major features of the present topography in areas where the drift is relatively thin; and (5) it must be considered in mapping the areal distribution of bedrock formations underlying the drift.

EVALUATION OF THE DATA

The bedrock-surface map, like all geologic maps, is a progress map which shows the status of existing information. It is therefore subject to revision as new data become available.

The accuracy of the map varies widely in different parts because of unequal distribution of data. In general the accuracy tends to diminish with increasing thickness of the glacial drift, although there are frequent exceptions to this generalization, depending largely on land use and the nature of glacial deposits and underlying bedrock. Borings which penetrate bedrock are usually numerous in suburban and industrial areas and in regions which have been tested for coal or oil; they are usually rare in areas where glacial outwash is close to the surface or where the drift is unusually thick. The control is relatively meager in the following counties which have thick drift and are dominantly rural: McHenry, southern DeKalb, southeastern Lee, northern Bureau, and western Henry counties in northern Illinois; and eastern Woodford, southern Iroquois, Ford, northern Vermilion, Champaign, Piatt, De Witt, and Mason counties in central Illinois (fig. 2).

Inasmuch as the bedrock-surface map represents a compilation of a large amount of

data accumulated over the past 70 years, it is believed that except for a few poorly controlled areas the interpretations of major valleys and uplands are secure. Future modifications of the map will probably be largely revisions and additions of tributary valleys and secondary uplands. Numerous valleys doubtless remain undiscovered because in many areas the records are too few to indicate their positions and connections.

MATERIALS AND METHODS

The bedrock-surface map is based almost entirely upon data available in publications and in the files of the Survey. Except for a week spent in collecting additional well records and locating bedrock exposures in critical areas, no special attempt was made to secure original data in the field.

The bulk of the primary data consists of the records of water wells which penetrated bedrock or important thicknesses of glacial drift. In many local areas the logs of oil wells and test-borings for coal provided additional information. Roughly 60,000 records were examined and plotted as datum points, either during the course of the study or previously by other workers. Because of the small scale of the map these datum points are not shown, but the original records are available in the files of the State Geological Survey and the State Water Survey.

The locations of borings vary considerably in accuracy and exactness. Most locations were determined by the driller or a member of the Survey staff; a few locations were determined from county maps showing land ownership. Where possible, elevations of the ground-surface were determined from United States Geological Survey quadrangle maps. In areas not covered by these maps, older topographic maps prepared by C. W. Rolfe or the base map of Illinois (1941) showing railroad elevations of towns were used to obtain elevations.

The locations and elevations of bedrock exposures were obtained from published reports and maps and from unpublished maps in the Survey files. Exposures are shown by the solid pattern in areas where geological maps are available; in areas where the data are incomplete, known exposures are shown by the triangular symbol (pl. 1). There are doubtless many areas in which rock exposures occur but are unreported.

Among the publications containing information on wells and bedrock exposures the following are particularly helpful:

Worthen, A. H., and assistants, Geological Survey of Illinois: Vols. 2, 3, 4, 5, and 6, 1866-75. County reports in these volumes contain records of early borings and mine shafts and for several areas contain the only references available on bedrock exposures.

Leverett, Frank, The Illinois glacial lobe: U. S. Geol. Survey Mon. 38, chap. XIV, pp. 550-797, 1899. Chapter XIV, Wells of Illinois, is a county-by-county treatment and is the most comprehensive reference on drift thicknesses throughout the State. Much original material unavailable elsewhere is included.

Mosier, J. G., Smith, R. S., and associates, County soil reports: Nos. 1 to 70, University of Illinois Agr. Exp. Sta., 1911-1941. Soil maps in these reports indicate bedrock exposures in many areas where geological maps are not available.

Krey, Frank, and Lamar, J. E., Limestone resources of Illinois: Illinois Geol. Survey Bull. 46, pp. 92-310, 1925. Gives accurate locations of the important limestone exposures within the State.

Ekblaw, George E., and assistants, Sand and gravel resources of Illinois: Illinois Geol. Survey files, unpublished maps. The most complete maps available showing locations of bedrock exposures in areas not covered by geological maps.

Quadrangle reports: Illinois Geol. Survey Bulls. 19, 26, 37, 38, 41, 43, 47, 48, 49, 51, 55, 57, and 66, 1912-1941; U. S. Geol. Survey Bull. 506, 1912; U. S. Geol. Survey, Geol. Atlas of U. S., Folios 67, 81, 185, 188, 195, 200, 208, 213, 216, and 220, 1900-1926.

Although the bedrock elevations obtained from well records and exposures were used as primary control, in many places local physiographic features were important aids in interpreting the bedrock surface. The present drainage pattern in some places clearly indicates drainage changes and the trend of buried bedrock valleys, as in the well known example of piracy shown by the canyon and headwaters of Apple River in Jo Daviess County (pl. 1). More often, the relations are only suggestive and require the support of subsurface data. The variations in width and profile of present valleys are usually even more significant and are generally related to the distribution of bedrock along streams. The region near Peoria

is an outstanding example. Just above Peoria the Illinois River enters a bedrock narrows bordered by prominent exposures and flows for about 15 miles to a point south of Pekin before re-entering a broad valley. The drainage change suggested by the present valley is verified by wells which indicate that the main bedrock valley, now completely buried, lies several miles to the east (fig. 12). Abandoned valleys or large valleys with underfit streams are more evident features which can usually be related to the bedrock surface. This is true of the Cache Valley in southern Illinois (pl. 1). In many places the steepness of valley walls and adjoining slopes and the texture of the drainage pattern suggest the influence of bedrock. This is especially helpful in areas where exposures are rare and widely scattered.

The pattern of bedrock exposures, where known in detail, often reveals bedrock-surface features not clearly reflected in the present topography. Discontinuities in more or less continuous outcroppings along streams usually show the presence of a bedrock valley transverse to the present stream. Relations of this type are clearly shown in McDonough County (pl. 1). In areas of thick drift the very existence of outcrops, particularly along small streams, generally indicates superposition onto bedrock uplands. The distribution of exposures in the northeastern quarter of the map emphasizes this point.

In those sections of the State where the Illinoian drift lies at the surface the relief of the bedrock surface in most places exceeds the thickness of the drift, and at least the major bedrock valleys and uplands are indicated by the present topography. Where thin drift mantles the bedrock numerous exposures provide control, and the present topography becomes the primary basis of interpretation. In regions where drift thicknesses approach the bedrock relief, major bedrock valleys and uplands are reflected in the drift-plain, although minor irregularities on the bedrock surface and some larger valleys are effectively buried. Reconstructions of the original uneroded Illinoian drift-plain were used in conjunction with other data in western Illinois and found to be important aids in interpreting the bedrock topography.[1] It was found in general that when moraine belts were excluded, the major bedrock valleys appeared as broad sags on the reconstructed till-plain and high areas on the till-plain coincided with bedrock uplands.

In the preparation of the report an attempt was made to present most of the basic descriptive material first and to include as much of the interpretation as possible in concluding sections. The report is divided into six sections in which the first two chapters (Chapter 1, Introduction and Chapter 2, Geological Background) are introductory; the next two chapters (Chapter 3, Physiographic Divisions of the Bedrock Topography, and Chapter 4, Bedrock Valley Systems) are largely descriptive; and the final two chapters (Chapter 5, Erosional History, and Chapter 6, Groundwater Resources of the Major Bedrock Valleys) are largely interpretive. Available data on the stratigraphy of the glacial deposits that fill the valleys are summarized in descriptions of the valleys, but detailed studies were not made except along Mahomet Valley in east-central Illinois and in the Joliet and Peoria regions.

PREVIOUS INVESTIGATIONS

The earliest references to the buried bedrock surface in the State are found in volumes of the original Geological Survey of Illinois published between 1866 and 1875 under the direction of A. H. Worthen.[2] Most of these references deal with drift thicknesses at specific localities, and no attempt was made to integrate the information. F. H. Bradley's[3] discussion of the bedrock topography in northeastern and east-central Illinois is an exception and represents the earliest attempt to recon-

[1]The reconstructions were compiled from topographic maps by eliminating in so far as possible the effects of erosion in post-Illinoian time. Maps of this type were prepared for the Annawan, Galva, Geneseo, Orion, Milan, Edgington, and Alexis quadrangles.

[2]Worthen, A. H., et al., Geol. Survey of Illinois, vols. 1-8, 1866-1875.

[3]Bradley, F. H., "Geology of Kankakee and Iroquois counties," pp. 226-40; "Geology of Champaign, Edgar and Ford Counties," pp. 266-74; *in* Geology and Paleontology: Geol. Survey of Illinois, vol. IV, 1870.

struct a major preglacial drainage system. Bradley postulated that a preglacial valley extended southward from Lake Michigan through Kankakee and eastern Iroquois counties into Champaign County and thence northwestward under the city of Bloomington into Illinois Valley in southern Tazewell County. It is now known that no continuous valley is present along this course and that the low bedrock elevations upon which it was based lie within independent drainage systems represented in the present report by Onarga, Mahomet, Danvers, and Mackinaw bedrock valleys (pl. 2).

Frank Leverett's studies[4] of the Illinois glacial lobe and groundwater resources of the State during the last decade of the last century included the first substantial contribution to an understanding of preglacial drainage lines. His discoveries were important and have provided the groundwork for later studies which have in the main verified his essential conclusions. The most significant of Leverett's contributions were: (1) The discovery, in conjunction with studies by J. A. Udden, of the buried valley of the ancient Mississippi between the present valley near Fulton and the big bend of Illinois River near Hennepin;[5] (2) the discovery of the buried bedrock valley of Rock River extending southward from Rockford to the ancient Mississippi near Hennepin;[6] (3) the conclusion that the preglacial drainage divide in northeastern Illinois was determined by the Niagara escarpment; (4) the recognition of unusually low bedrock elevations in east-central Illinois along Mahomet Valley shown in this report; (5) the conclusion that the Mississippi, Illinois, and Wabash valleys in most places are preglacial; and (6) the conclusion that the major features of the bedrock surface over most of southern and western Illinois are reflected in the present topography. In addition Leverett pointed out the significant drainage changes brought about by the Illinoian and Wisconsin glacial invasions in northwestern and western Illinois, especially with respect to the Mississippi River.[7] Except for a discussion and review of the literature by H. M. Clem[8] in 1910, Leverett's studies represent the last regional treatment of the bedrock surface of Illinois.

Subsequent studies of the bedrock surface are found in reports on local areas within the State, many of which include outline or contour maps of the preglacial topography.

Udden, Johan A., Geology and mineral resources of the Peoria quadrangle, Illinois: U. S. Geol. Survey Bull. 506, pl. 5, p. 52, 1912. Contour map of bedrock surface; 50-foot contour interval.

Shaw, E. W. and Savage, T. E., U. S. Geol. Survey Geol. Atlas, Tallula-Springfield folio (No. 188), fig. 13, p. 10, 1913. Outline map of preglacial topography. Names "Athens Valley."

Peattie, Roderick, Topography of the bedrock under Chicago: Jour. Western Soc. Engineers, vol. 19, pp. 590-611, 1914. Map showing bedrock elevations.

Udden, Johan A. and Shaw, E. W., U. S. Geol. Survey Geol. Atlas, Belleville-Breese folio (No. 195), fig. 10, p. 9, 1915. Contour map of bedrock surface; 50-foot contour interval.

Cady, G. H., Geology and mineral resources of the Hennepin and LaSalle quadrangles: Illinois Geol. Survey Bull. 37, pl. V, facing p. 96, 1919. Contour map of bedrock surface; 100-foot contour interval.

Hinds, Henry, U. S. Geol. Survey Geol. Atlas, Colchester-Macomb folio (No. 208), fig. 11, p. 9, 1919. Sketch map of preglacial topography.

Savage, T. E. and Nebel, M. L., Geology and mineral resources of the La Harpe and Good Hope quadrangles: Illinois Geol. Survey Bull. 43A, fig. 9, p. 49, 1921. Sketch map of preglacial topography.

Culver, Harold E., Geology and mineral resources of the Morris quadrangle: Illinois Geol. Survey Bull. 43B, fig. 33, p. 61, 1922. Contour map of bedrock surface; 25-foot contour interval.

Bretz, J Harlen, Geology and mineral resources of the Kings quadrangle: Illinois Geol. Survey Bull. 43C, fig. 69, p. 282, 1923. Map showing pre-Illinoian drainage pattern.

Lamar, J. E., Geology and mineral resources of the Carbondale quadrangle: Illinois Geol. Survey Bull. 48, fig. 19, p. 113, 1925. Sketch map showing areas of thick and thin glacial drift in the northern half of the quadrangle.

Fisher, D. J., Geology and mineral resources of the Joliet quadrangle: Illinois Geol. Survey

[4]The preglacial valleys of the Mississippi and its tributaries: Jour. Geology, vol. 3, pp. 740-63, 1895; The water resources of Illinois: U. S. Geol. Survey, Ann. Rept. 17, pt. 2, pp. 695-828, 1896; The Illinois glacial lobe: U. S. Geol. Survey Mon. 38, 817 pp., 1899; The lower rapids of the Mississippi River: Jour. Geology, vol. 7, pp. 1-22, 1899, and Proc. Iowa Acad. Sci., vol. 6, pp. 74-93, 1899.

[5]Princeton Valley of this report.

[6]Pawpaw Valley of this report.

[7]See footnote 4.

[8]Clem, H. M., The preglacial valleys of the Upper Mississippi and its eastern tributaries: Proc. Ind. Acad. Science, 1910, pp. 335-52, 1911.

Bull. 51, pl. 11, 1925. Contour map of bedrock surface; 10-foot contour interval.

Knappen, R. S., Geology and mineral resources of the Dixon quadrangle: Illinois Geol. Survey Bull. 49, pl. IV, facing p. 98, 1926. Map showing drainage changes resulting from Illinoian glaciation.

Lee, Wallace, U. S. Geol. Survey Atlas, Gillespie-Mount Olive folio (No. 220), fig. 12, p. 11, 1926. Contour map of the preglacial topography; 50-foot contour interval.

Athy, L. F., Geology and mineral resources of the Herscher quadrangle: Illinois Geol. Survey Bull. 55, fig. 30, p. 87, 1928. Contour map of bedrock topography; 25-foot contour interval.

Wanless, H. R., Geology and mineral resources of the Alexis quadrangle: Illinois Geol. Survey Bull. 57, pl. IV, 1929. Contour map of bedrock surface; 20-foot contour interval.

Bell, A. H., and Leighton, M. M., Illinoian, Kansan, and Nebraskan drifts near Winchester, Illinois: Bull. Geol. Soc. Amer., vol. 40, fig. 4, p. 488, 1929. Contour map of bedrock surface of parts of the Winchester and Griggsville quadrangles; 20-foot contour interval.

Caldwell, L. T., A study of the stratigraphy and the preglacial topography of the DeKalb and Sycamore quadrangles: Unpublished master's thesis, University of Chicago, 22 pp., 1936. Contour map of bedrock topography; 50-foot contour interval.

Workman, L. E., The preglacial Rock River valley as a source of groundwater for Rockford: Trans. Illinois Acad. Sci., vol. 30, fig. 1, p. 246, 1938. Contour map of preglacial valley of Rock River near Rockford; 50-foot contour interval.

Willman, H. B., Preglacial River Ticona: Trans. Illinois Acad. Sci., vol. 33, p. 173, 1940. Preglacial drainage map of LaSalle, Grundy, and parts of adjoining counties.

Emery, K. O., Electrical earth-resistivity survey at Peoria and vicinity: Illinois Geol. Survey unpublished manuscript, 12 pp., 11 figs. Contour map of bedrock topography at Peoria and vicinity; 20-foot contour interval.

Willman, H. B., and Payne, J. N., Geology and mineral resources of the Marseilles, Ottawa, and Streator quadrangles: Illinois Geol. Survey Bull. 66, pls. 4, 5, and 6, 1942. Contour maps of bedrock surface in the three quadrangles; 25-foot contour interval.

Horberg, Leland, and Emery, K. O., Buried bedrock valleys east of Joliet and their relation to water supply: Illinois Geol. Survey Cir. 95, pl. 1, 1943. Contour map of bedrock surface in vicinity of Joliet; 10-feet contour interval.

Horberg, Leland, A major buried valley in east-central Illinois and its regional relationships: Jour. Geology, vol. 53, pp. 349-59, 1945. Contour map of bedrock surface; 50-foot contour interval.

ACKNOWLEDGMENTS

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CHAPTER 2—GEOLOGIC BACKGROUND

ORIENTATION IN THE GEOLOGIC TIME SCALE

The present topography is the uppermost and youngest of a long succession of land surfaces which extend back into the earliest records of the geologic past. These older land surfaces occur at various levels in the outer shell of the earth and are often overlain by hundreds of feet of solid rock. They are buried erosion surfaces, or *unconformities*, and represent physically unrecorded intervals in the geologic time scale, whereas the rocks themselves comprise the physical record.[1]

In Illinois one of the most profound unconformities in the record separates the surficial deposits of glacial drift from the underlying bedrock. It represents that part of geologic time between the close of the Pennsylvanian period and the advance of the Pleistocene glaciers—an estimated lapse of about 225 million years (table 1). The Permian system and most of the entire Mesozoic and Cenozoic sequences, which are represented elsewhere by thousands of feet of rock, are absent from the record. It is improbable, however, that 225 million years were required for the erosion of the present bedrock surface. Instead the available evidence indicates that the preglacial surface is largely the result of erosion in late Tertiary and early Pleistocene time—that is, during the closing stages of the interval represented by the unconformity. The older land surfaces formed during the early part of the lost interval were destroyed as younger and lower surfaces were eroded, so that only the most recent are preserved as the present bedrock topography.

[1]The irregular boundaries separating certain strata in figure 4 indicate the positions of unconformities.

PREGLACIAL STREAM EROSION AND STREAM TYPES

The bedrock topography, whether buried or at the surface, is believed to be primarily the product of erosion by streams. Modifications of the surface by glacial erosion may have been significant in certain areas, especially in the northern part of the State, but in total these were probably unimportant.[2]

Landforms produced by stream erosion are determined by: (1) The structure[3] of the underlying bedrock; (2) the stage to which erosion has progressed; and (3) the relief available on the initial landsurface. As the relation of streams to structure is an important consideration in the chapters which follow, the main types are described briefly at this point.

In their relation to structure, streams are classified as consequent, subsequent, obsequent, resequent, and insequent (fig. 1). A *consequent* stream is one whose position is determined by the initial slope of a land surface so that in general the flow is down the dip of underlying beds. A *subsequent* stream is localized along a belt of weak rock and in most cases follows the trend or strike of underlying formations. *Obsequent* streams flow in directions opposite to those of the original consequent streams of the region and opposite to the dip of the bedrock.

[2]Discussion of the extent of glacial erosion in Illinois is beyond the scope of the present report, but there are a number of lines of evidence which support the above conclusion: (1) There is no indication of glacial overdeepening of the major bedrock valleys, as bedrock elevations along these valleys fulfill requirements of normal stream gradients; (2) the fact that soils and weathering profiles are more commonly preserved than not on the buried drift-sheets of central Illinois indicates that there was only slight erosion by the Illinoian and Wisconsin ice-sheets in this region; and (3) in areas where control is closely spaced so that numerous wells are present within a single section, as in the Chicago and Joliet regions, branching valleys with normal stream gradients provide the only logical basis for interpreting the data.

[3]In geomorphic discussions the term *rock structure* is used in a general sense to include the lithology and original distribution of bedrock formations as well as features due to subsequent deformation.

TABLE 1.—DIVISIONS OF GEOLOGIC TIME

Eras	Periods	Epochs	Stages	Characterization	Estimated length in years
CENOZOIC			Recent	postglacial	25,000
	Pleistocene		Wisconsin Sangamon Illinoian Yarmouth Kansan Aftonian Nebraskan	glacial interglacial glacial interglacial glacial interglacial glacial	2 million
	Tertiary	Pliocene Miocene* Oligocene* Eocene Paleocene		Rise of mammals	58 million
MESOZOIC	Cretaceous Jurassic* Triassic*			Age of reptiles	125 million
PALEOZOIC	Permian* Pennsylvanian Mississippian Devonian Silurian Ordovician Cambrian			Age of invertebrates	370 million
PRECAMBRIAN				Remains of life mostly lacking Buried below younger rocks in Illinois	1450+ million

*No physical record in Illinois

Resequent streams flow down dip in the direction of the original consequents but they develop later and at a lower level. Both obsequent and resequent streams are generally tributary to subsequent valleys. *Insequent* streams are those whose positions are due to indeterminate causes. Two other types of streams whose courses usually lie transverse to structure are classed as superimposed and antecedent. *Superimposed* streams are those whose courses were originally acquired on an unconformable cover of flat-lying sediments but have later entrenched themselves across the structure of underlying rocks. An *antecedent* stream is one which maintains its position across an uplift by eroding down at a rate faster than the rate of uplift. Transverse streams can be recognized as superimposed or antecedent only after the erosional history of the region has been deciphered.

By the beginning of the glacial period streams had probably reduced the bedrock surface to essentially its present level over most of the State, and the major bedrock valleys had been eroded to their maximum depths. During the succeeding glacial period deposition rather than erosion was the dominant geologic process.

GLACIAL HISTORY

The Pleistocene or glacial period is the geologic time division immediately preceding the "Recent." In terms of estimated years it began about two million years ago and came to a close about 25,000 years ago. During the four glacial stages of the Pleistocene, continental ice-sheets formed about three great centers in eastern, central, and western Canada. From the eastern Labradorean center on the Labrador Peninsula and the Keewatin center west of Hudson Bay the ice at various times advanced south-

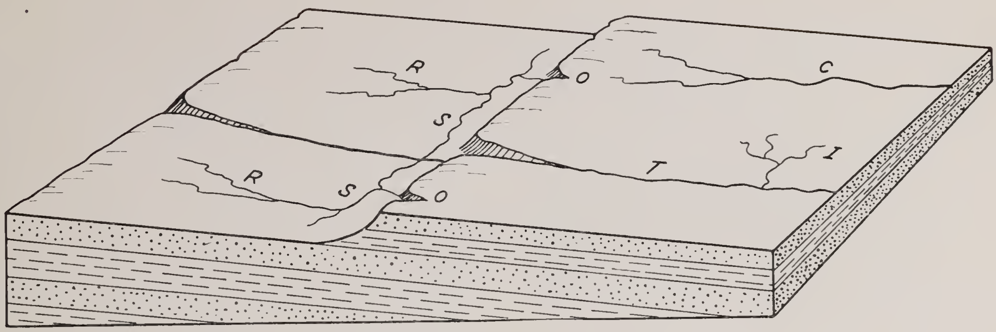

FIG. 1.—Diagram showing types of streams. C—consequent stream; S—subsequent stream; O—obsequent stream; R—resequent stream; I—insequent stream; T—transverse stream may be either superimposed or antecedent.

ward and ultimately covered most of the Mississippi drainage basin. Ice from the Cordilleran center in western Canada, however, did not reach the central part of the United States. The advance of the ice into Illinois was controlled to an important extent by the preglacial landsurface in the Great Lakes region, so that in general the advance was down the Lake Michigan basin and into the broad lowland in the central part of the State.

Four independent stages of glaciation are recognized in the Mississippi Valley region. These are, from oldest to youngest, Nebraskan, Kansan, Illinoian, and Wisconsin. The directions from which the ice advanced during various glaciations are shown graphically in figure 21, page 100. The glacial stages were separated by interglacial stages which probably exceeded recent geologic time in duration and during which the climate was probably as temperate as it is at present. During the earliest glacial advance, Nebraskan ice from the Keewatin center entered the State from the northwest and probably covered most of the upland between the present Mississippi and Illinois rivers (fig. 21). The succeeding Kansan glaciation appears to have advanced from both the Labradorean and Keewatin centers of glaciation, possibly in that order, and together covered about three-fourths of the State. The Labradorean ice was most extensive and may have extended south as far as Randolph County; the Keewatin glacier appears to have covered much the same area as the preceding Nebraskan ice-sheet. During the Illinoian glaciation which followed, the maximum extent of the ice was attained and all of the State was covered with Labradorean ice from the northeast except for small driftless areas in the northwestern corner and southern tip of the State and a narrow strip of western Illinois. The final Wisconsin glaciation in Illinois also involved the Labradorean center, and ice from the northeast moved down the basin of Lake Michigan during several substages. During its maximum extent it covered roughly one-third of the State. The surficial drift in Illinois was deposited for the most part by Wisconsin and Illinoian ice; the deposits left by the two earlier ice-sheets were largely concealed by the younger drift-sheets (fig. 9).

The configuration of the ice-sheets in a number of places can be related directly to bedrock-surface features. In connection with Illinoian glaciation, the maximum extent of the ice in southern and western Illinois was undoubtedly determined in large measure by the barrier formed by Shawneetown ridge and the Meramec-Osage ridge (compare figs. 5 and 9). In connection with the Wisconsin glaciation, the outstanding examples are provided by the advance of Tazewell ice into the Green River Lowland to form the Green River lobe and into the broad valley of Rock River south of Rockford to form the Belvidere lobe.

The various glacial advances were responsible for numerous drainage changes which can be related in part to features of the bedrock topography. In many places the preglacial valleys were completely buried and new channels were established. Preglacial and interglacial drainage lines were succeeded by a recent generation of streams whose youthful valleys were determined largely by initial irregularities of the drift-sheets.

The present broad rolling prairie-lands of the Wisconsin drift-sheet represent a surface of glacial deposition on which as yet no major valleys have been eroded. Even sizable streams are flowing essentially on the original land surface formed by the drift. The older Illinoian drift-sheet, however, has been modified extensively by post-glacial erosion.

TYPES OF GLACIAL DEPOSITS

The general term applied to all glacial deposits, whether deposited directly by the ice or by glacial meltwater, is *glacial drift.* More specifically the bouldery clay deposited by the ice is called *till,* and the stratified sediments of sand and gravel laid down by glacial streams are termed *outwash.* The most important glacial landforms are: (1) *End* or *terminal moraines* which are broad continuous ridges of till formed by accumulation of detritus at the edge of a glacier where the ice front was more or less stationary; (2) *ground moraines* which include the wide stretches of gently rolling plains between end moraines; (3) *outwash plains* which are plains of sand and gravel built up along the front of the ice-sheet; and (4) *valley trains* which are outwash deposits laid down in valleys draining away from the ice front.

CHAPTER 3—PHYSIOGRAPHIC DIVISIONS OF THE BEDROCK TOPOGRAPHY

PRESENT PHYSIOGRAPHIC DIVISIONS

All of Illinois is included in the Central Lowland physiographic province of the United States except for the southern driftless portion of the State which includes small segments of the Ozark Plateaus (Interior Highland), Interior Low Plateaus, and Coastal Plain provinces (fig. 3).[1] Three subdivisions of the Central Lowland are represented: the *Till Plains section* covering about four-fifths of the State; the *Great Lake section* lying inside the Valparaiso moraine in northeastern Illinois; and the *Wisconsin Driftless section* in the northwestern corner of the State.[2]

The Till Plains section, which coincides closely with the Wisconsin and Illinoian drift-sheets, is characterized by youthful plains on which the original features of glacial deposition are widely preserved. The Wisconsin drift-sheet is in an early stage of stream dissection so that large areas are without important valleys. In contrast, stream erosion has cut deeply into the Illinoian drift, and in many areas more than half of the original glacial plain has been dissected. The section is differentiated from the Dissected Till Plains west of the Mississippi which are maturely eroded and preserve only small remnants of the original glacial plain. The Great Lake section includes the youngest drift in the State and is distinguished by essentially uneroded morainic topography with numerous undrained depressions that enclose lakes and swamps. In the Wisconsin Driftless section resistant bedrock formations have been maturely eroded so that the region is rugged and hilly as compared with other parts of northern Illinois, and has a local relief of 300 to almost 500 feet.

[1]Figure 2 showing county names and the township grid may be used as reference to figure 3 and to subsequent maps on which geographic details have been omitted.
[2]Fenneman, N. M., Physiography of Eastern United States, pls. IV and VI, McGraw-Hill, N. Y., 1938.

Subdivisions of the Till Plains section have been outlined recently by Leighton, Ekblaw, and Horberg[3] and are shown in figure 3.

The southern driftless portion of the State includes small segments of (1) the Shawnee Hills section[4] of the Interior Low Plateaus, (2) the Salem Plateau and Lincoln Hills sections of the Ozark Plateaus, and (3) the Coastal Plain (fig. 3). The region as a whole is largely hill country and is known popularly as the "Illinois Ozarks." It includes rugged, maturely dissected cuestas and fault-line scarps together with low hills and broad alluviated valleys. Highest elevations are along the Pennsylvanian escarpment along the northern edge of the Shawnee Hills.

PREGLACIAL PHYSIOGRAPHY

In its broadest aspect the topography of the Mississippi Valley region just before the glacial period was a central lowland, as it is at present. The preglacial subdivisions of this province, however, were quite different from the present sections which are based on glacial features. The composition and geographic distribution of the bedrock formations were the primary causes of topographic contrasts, and sectional boundaries would be drawn along stratigraphic contacts, much as they are at present outside the glacial boundary. Thus the most extensive lowlands were developed where relatively weak Pennsylvanian strata form the bedrock, and secondary lowlands were eroded on the black shales of Upper Devonian and Lower Mississippian age and on the Ordovician Maquoketa shale. The

[3]Leighton, M. M., Ekblaw, George E., and Horberg, Leland, Physiographic Divisions of Illinois: Jour. Geology, vol. 56, No. 1, pp. 16-33, 1948; Illinois Geol. Survey Rept. Inv. 129, 1948.
[4]Fenneman, op. cit., p. 435. The Shawnee Hills section was originally distinguished by R. F. Flint and named the "Shawnee Hill section." Flint, R. F., Natural boundaries in the Interior Low Plateau physiographic province: Jour. Geology, vol. 36, pp. 451-57, 1928.

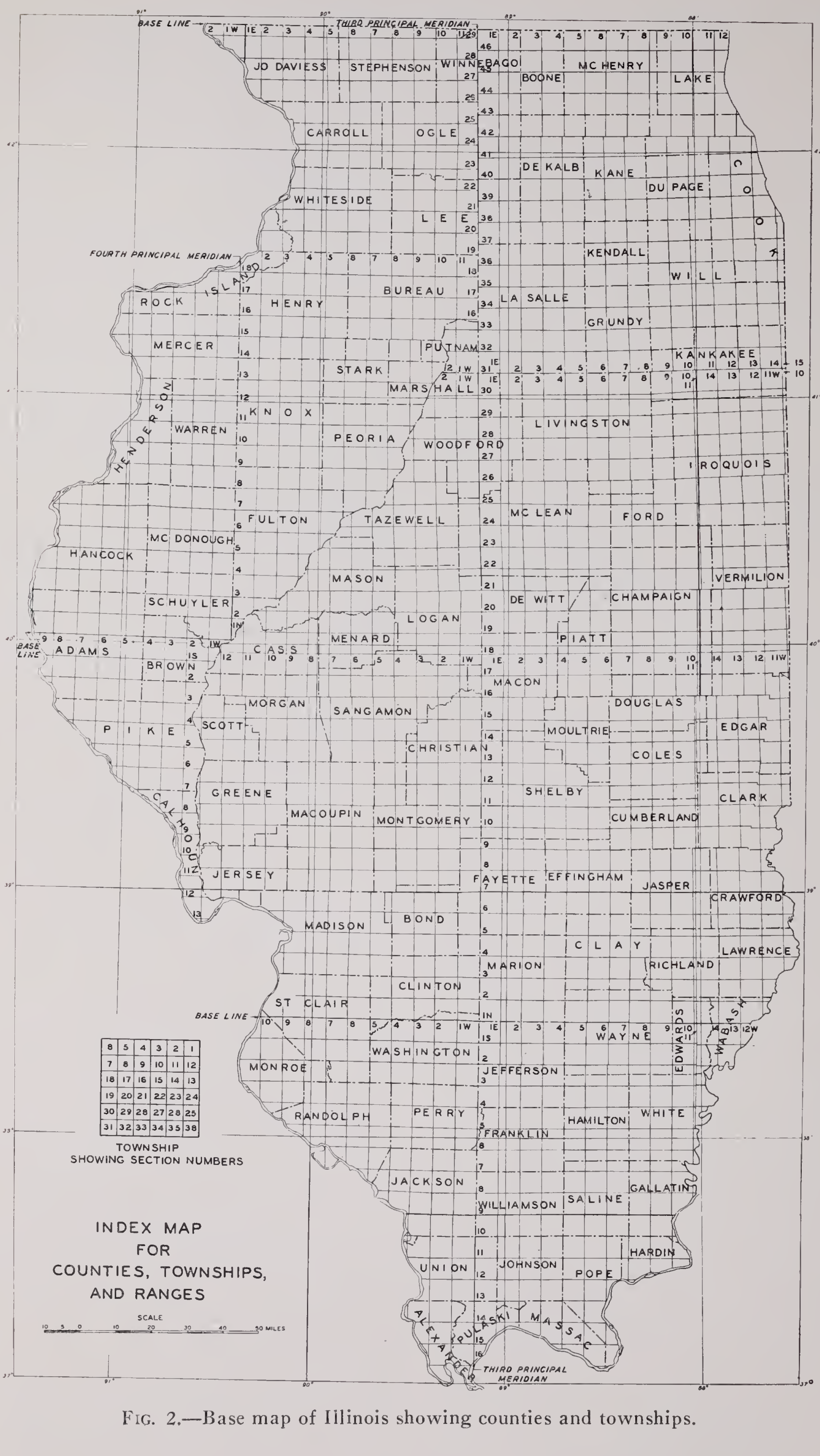

FIG. 2.—Base map of Illinois showing counties and townships.

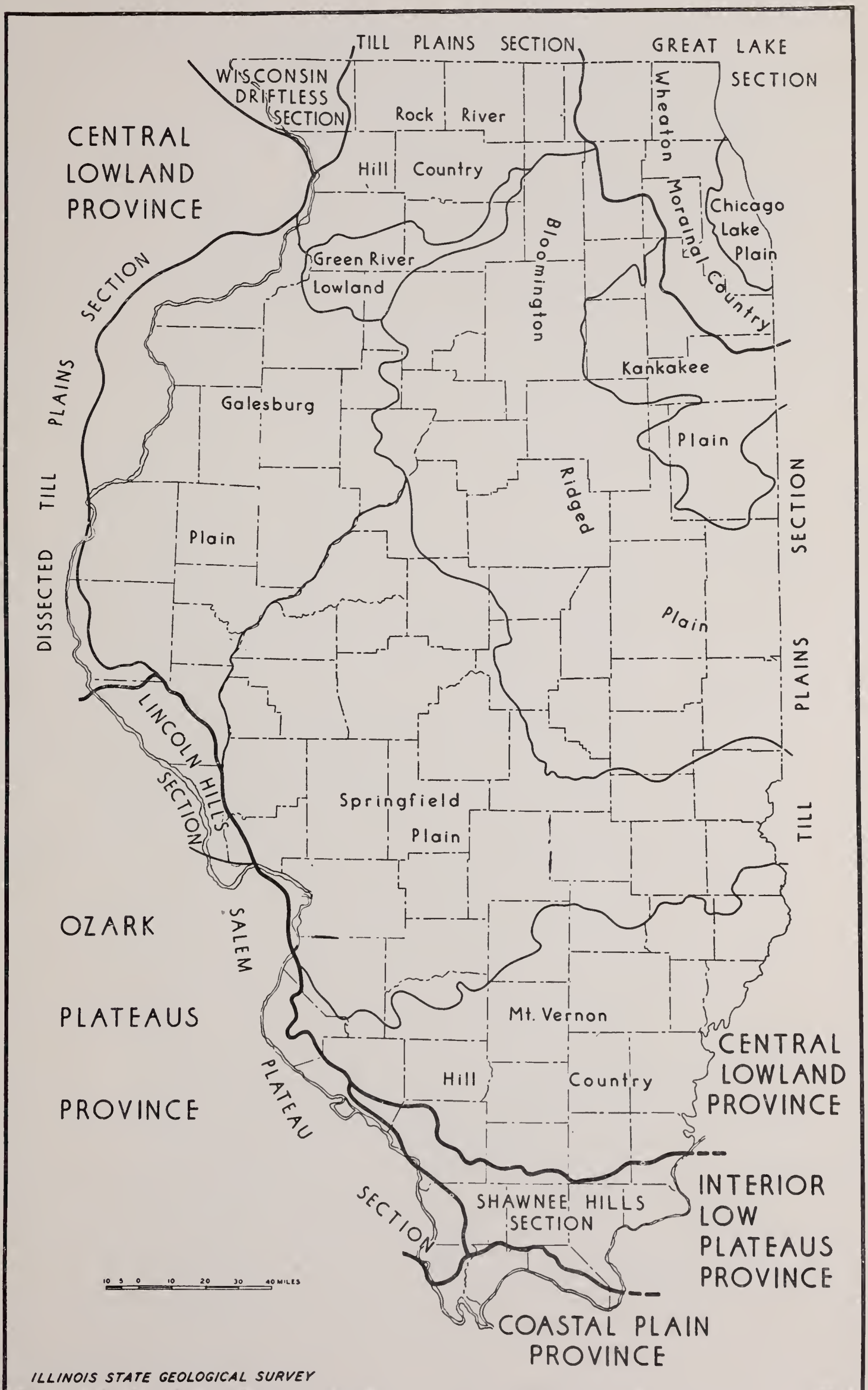

FIG. 3.—Physiographic divisions of Illinois.

SYSTEM	SERIES, GROUP OR FORMATION	FEET
PLEISTOCENE	GLACIAL DRIFT	75
PLIOCENE ?	"LAFAYETTE" GRAVEL	20
EOCENE	WILCOX SAND	125
	MIDWAY SAND	100
CRETACEOUS	McNAIRY SAND	200
PENNSYLVANIAN	McLEANSBORO GROUP	1000
	CARBONDALE GROUP	250
	TRADEWATER GROUP ⎫ "POTTSVILLE"	450
	CASEYVILLE GROUP ⎭	200
MISSISSIPPIAN	CHESTER SERIES	1000
	MERAMEC GROUP: STE GENEVIEVE LIMESTONE, ST LOUIS LIMESTONE, SALEM LIMESTONE	500
	OSAGE GROUP: WARSAW SHALE, KEOKUK LIMESTONE, BURLINGTON LIMESTONE, FERN GLEN LIMESTONE	400
	KINDERHOOK GROUP	300
DEVONIAN	ALTO LIMESTONE, LINGLE LIMESTONE / CEDAR VALLEY LS	150
	GRAND TOWER LIMESTONE / WAPSIPINICON LS.	100
	CLEAR CREEK CHERT	300
	BACKBONE LIMESTONE	250
	GRASSY KNOB CHERT	200
	BAILEY LIMESTONE	200
SILURIAN	NIAGARAN DOLOMITE	300
	ALEXANDRIAN DOLOMITE	100
ORDOVICIAN	MAQUOKETA SHALE	150
	GALENA (KIMMSWICK) DOLOMITE	200
	PLATTIN (PLATTEVILLE) LIMESTONE	150
	ST. PETER SANDSTONE	100-500
	SHAKOPEE DOLOMITE	150
	NEW RICHMOND SANDSTONE	100
	ONEOTA DOLOMITE	200
CAMBRIAN	TREMPEALEAU DOLOMITE	200
	FRANCONIA DOLOMITE	100
	GALESVILLE SANDSTONE	200
	EAU CLAIRE SHALE	400
	MT. SIMON SANDSTONE	100
PRE-CAMBRIAN ?	FOND DU LAC SANDSTONE	1500-2000
PRE-CAMBRIAN	CRYSTALLINE ROCKS	

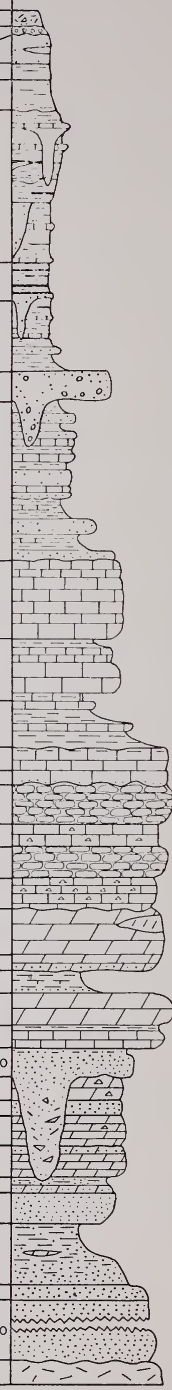

FIG. 4.—Generalized columnar section of the bedrock formations in Illinois. Thickness figures are approximate averages for areas in which the formations form the bedrock surface.

FIG. 5.—Paleophysiographic diagram of the bedrock topography of Illinois.

remaining rocks in the geologic column (fig. 4) are more resistant to erosion and give rise to cuestas and uplands. Among the most conspicuous scarp-formers are the Niagaran dolomite, the Galena dolomite, the Burlington limestone, and the basal Pennsylvanian (Tradewater) sandstones.

The areal distribution of formations in the Mississippi Valley is determined primarily by geologic structure, so that the structural elements of the region are broadly reflected in the preglacial physiography. The Illinois basin, the Michigan basin, and the Forest City basin of Iowa are areas in which extensive lowlands were eroded to relatively low elevations. Uplands and higher cuestas were developed along the axes and flanks of positive structures where older rocks came to the surface. These include the Cincinnati arch, the Kankakee arch, the Wisconsin arch, the Ozark dome, and the broad uplift separating the Illinois and Forest City basins. The preglacial physiography of Illinois is controlled to a large extent by the occurrence of weak Pennsylvanian beds in the Illinois basin which were eroded into a broad lowland covering almost three-fourths of the State (fig. 5). Other physiographic regions on the older rocks around the margin of the lowland are determined structurally by the Ozark dome and its associated structures, the Wisconsin arch and the Kankakee arch.

PREGLACIAL PHYSIOGRAPHIC DIVISIONS

Because the bedrock formations are of primary importance in defining the preglacial physiographic divisions, stratigraphic names, rather than geographic names have been adopted. In the driftless or essentially driftless areas the established present physiographic divisions are retained.

The physiographic divisions of the bedrock surface (fig. 6) adopted for the descriptions which follow are given below:

- Buried physiographic divisions:
  - Preglacial Central Lowland
    - Niagara Cuesta of northeastern Illinois
    - Galena Upland
    - Silurian Upland of northwestern Illinois
    - Pennsylvanian Upland of western Illinois
    - Pennsylvanian Lowland of central Illinois
      - Green River Lowland
      - Havana Lowland
      - Kaskaskia Lowland
      - Wabash Lowland
    - Meramec-Osage Upland
- Essentially present physiographic divisions
  - Ozark Plateaus province
    - Lincoln Hills section
    - Salem Plateau section
  - Interior Low Plateaus province
    - Shawnee Hills section
  - Coastal Plain province
    - Cache Valley
    - East Gulf Coastal Plain
    - Mississippi Alluvial Plain

BURIED PHYSIOGRAPHIC DIVISIONS

Niagara Cuesta in Northeastern Illinois

Definitions and Regional Relations.—The northeastward sloping upland in northeastern Illinois, underlain by resistant Silurian dolomites of Alexandrian and Niagaran age (fig. 7), is termed the *Niagara cuesta,* and its south and west-facing scarp is called the *Niagara escarpment.* The escarpment follows the Silurian-Ordovician boundary from the Wisconsin state line southward into Kankakee County where the contact is between Silurian rocks and younger overlapping Pennsylvanian and possibly Devonian strata. The northeastern margin of the cuesta would follow the Silurian-Devonian contact along the bottom of Lake Michigan.

The cuesta is a regional bedrock feature which can be traced westward through New York State, northward around the shores of Lakes Huron and Michigan, and southward along the west shore of Lake Michigan into Illinois. In eastern Wisconsin it has been termed the "Niagara Upland."[5]

Rock Structure.—The Silurian strata in northeastern Illinois strike essentially north-south and have a regional eastward dip averaging about 15 feet per mile (figs. 8 and 19). Upon this dip-slope are superposed a series of low folds which trend southeastward. In western Kankakee and southwestern Will counties the regional

[5]Martin, Lawrence, The physical geography of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 36, p. 37, 1932.

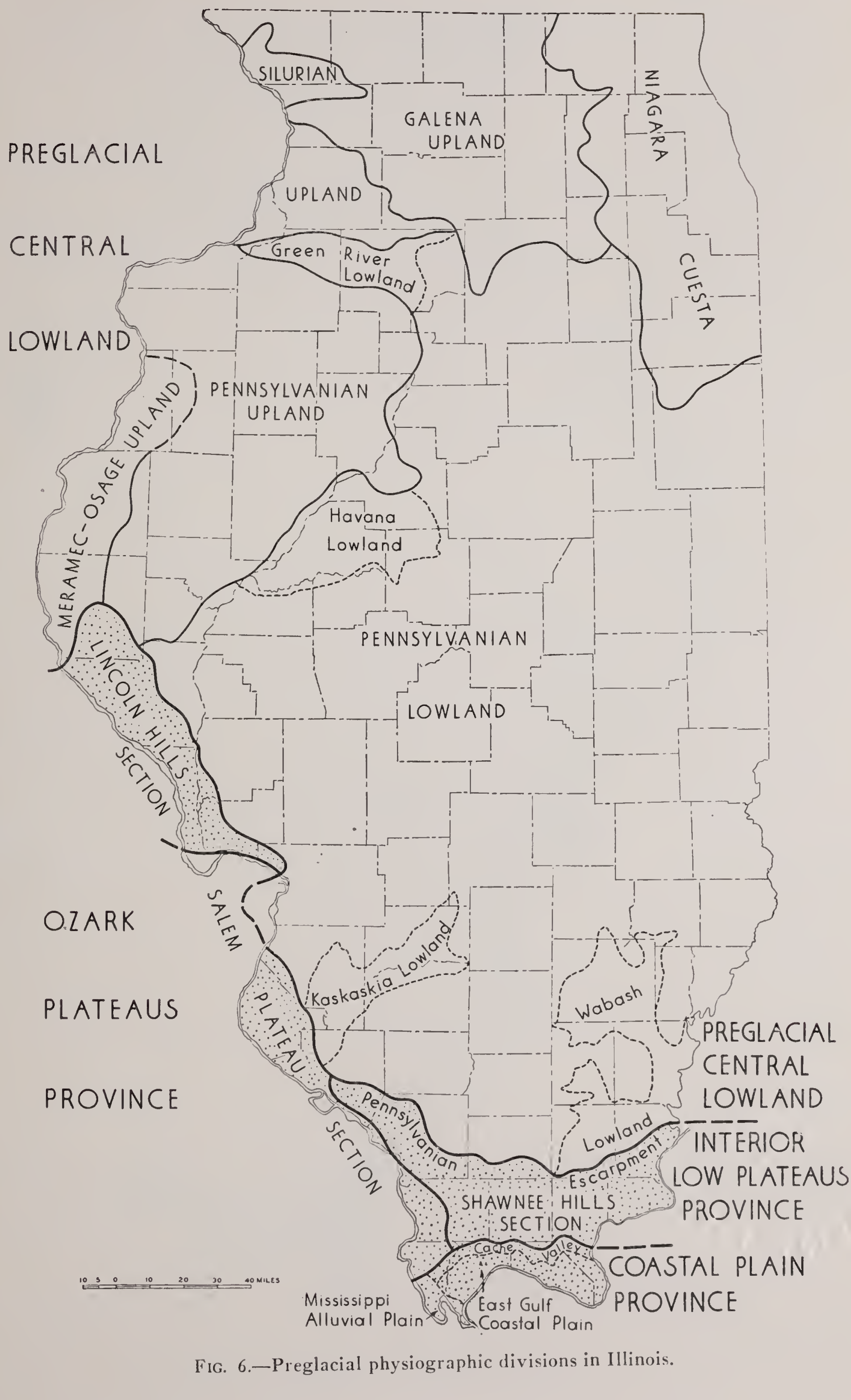

Fig. 6.—Preglacial physiographic divisions in Illinois.

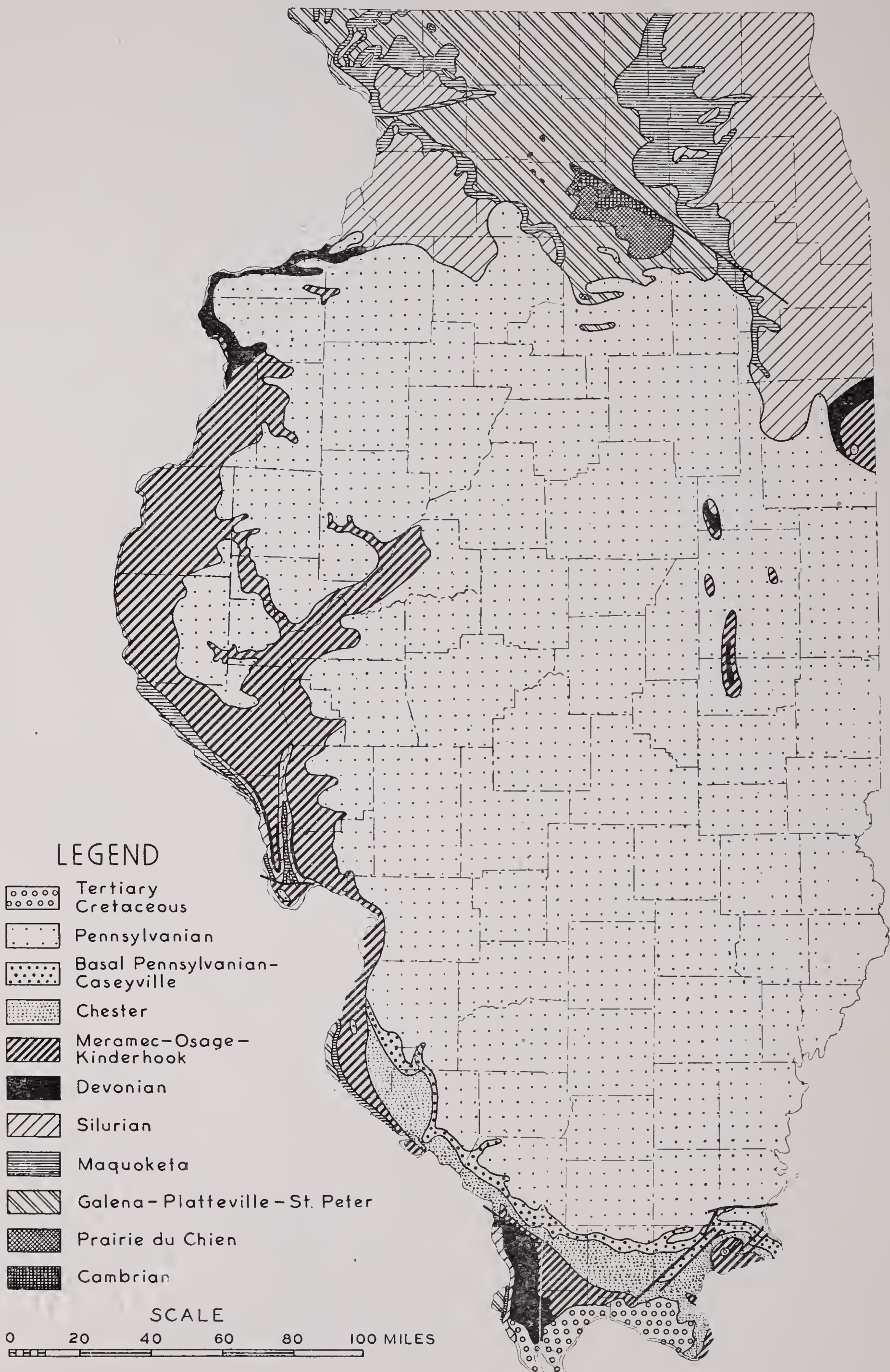

FIG. 7.—Generalized geological map of Illinois. Compiled from Geological Map of Illinois by J. Marvin Weller, 1945.

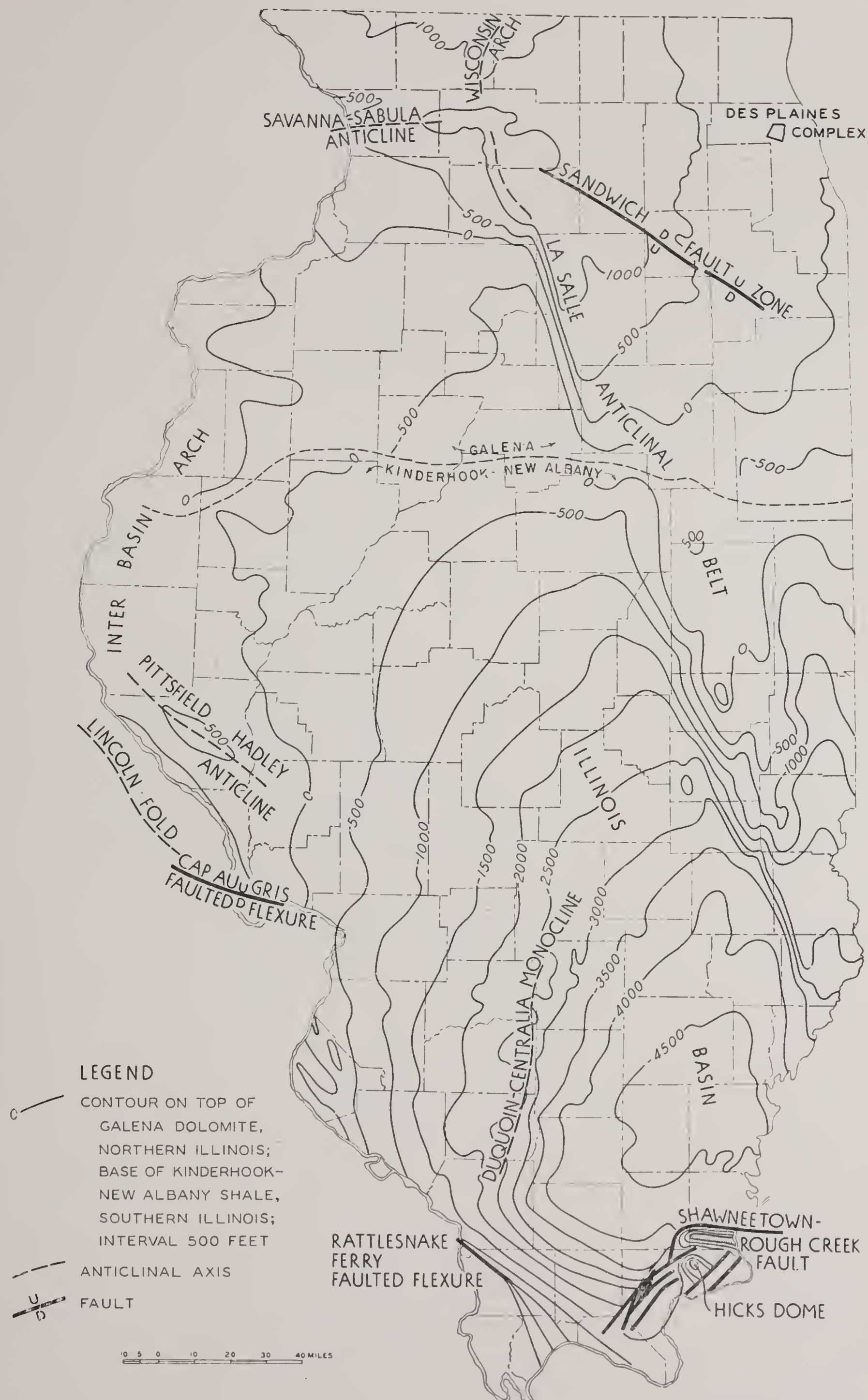

Fig. 8.—Major bedrock structures in Illinois. Based on studies by A. H. Bell and J. Marvin Weller and on well records in the Illinois Geological Survey files.

structure is complicated by a north-south trending anticline.

The Silurian formations comprise a resistant dolomite unit of uniform composition with a maximum thickness of about 450 feet in the Chicago region (fig. 4). Large reef (bioherm) structures in the upper part of the system (Waukesha and Racine formations) are resistant to erosion and give rise to klintar. A few of these reefs are known from surface exposures in the Chicago region at Stony Island, Thornton, and Chicago Heights, and others are buried below the glacial drift.

Topography.—The frayed outer margin of the cuesta is largely concealed by glacial drift so that its position is determined almost entirely from subsurface data (pl. 1). It enters the State near the northwest corner of McHenry County as part of the prominent upland that centers near Harvard, Illinois. The bedrock upland at this point reaches a maximum elevation of about 900 feet, which represents the highest point along the crest of the entire cuesta. In the southern part of the county and continuing south through Kane County, the scarp appears to be frayed and broken into numerous outliers. Continuing southward into Kendall County, the scarp forms a westward bulge and swings eastward into western Will County, from which point it can be traced southward across western Kankakee and into northwestern Iroquois County as a fairly linear, north-south trending front. The southern margin of the cuesta is not sharply defined but appears to follow the southern margin of a dissected south-sloping upland in northern Iroquois County. The trend of the cuesta as a whole is slightly east of south.

The highest elevations lie across the crest of the upland five to ten miles east of the outer margin, and in general the crest slopes southward from an elevation of about 900 feet above sea-level in McHenry County to elevations of 650-700 feet in Will and Kankakee counties. It is significant that the lowest points along the crest occur in southern DuPage and northern Will counties where the Lake Chicago outlet and the older Hadley Valley spillway transect the ridge.

The broad backslope of the cuesta is relatively flat and is not deeply dissected. It slopes gently eastward from elevations of 650 feet or more at the crest to about 550 feet at Lake Michigan.

In as far as can be determined from subsurface studies, the cuesta appears to be maturely to submaturely eroded and in most places has a local relief of less than 100 feet. Maximum local relief is found in northwestern McHenry County where there is a difference in elevation of at least 370 feet within a distance of about seven miles.

Drainage Relations.—South of central Kane County the crest of the cuesta formed the preglacial watershed between drainage eastward into the Lake Michigan lowland and westward and southward into the Pennsylvanian Lowland of central Illinois (pl. 2). The east-draining valleys on the backslope are uniformly spaced and of about equal size. In general they parallel the dip of the underlying strata or diverge slightly to the northeast which suggests that they are resequent tributaries of a subsequent valley in the belt of Devonian shales to the east. In northern Kane and southern McHenry counties two major valleys appear to head west of the cuesta in areas underlain by Maquoketa shale.

Drainage lines along the front of the cuesta are much more irregular than those on the backslope. South of Kane County the west-sloping valleys are tributaries to the Newark-Kempton drainage basin which is eroded largely in the Maquoketa shale to the north and in Pennsylvanian rocks farther south. Many could be classified as obsequent valleys. In McHenry County the subsurface interpretation indicates that there is but little relation between drainage development and the underlying strata. Similarly the position of Newark Valley in Kane County is anomalous with underlying bedrock.

Relation to Present Topography.—The Niagara cuesta is completely buried by glacial drift and is unrelated to present topography except for a restricted area in

southwestern Will County. In this area the present upland front east of Kankakee River coincides with the Niagara cuesta for a distance of about ten miles (fig. 9).

Galena Upland

Definition and Boundaries.—The complex upland in northwestern and north central Illinois is referred to as the *Galena Upland* because the Galena dolomite is the most widespread formation underlying the drift (figs. 6 and 7). The eastern and western boundaries of the upland follow the Niagara escarpment, and the southern margin roughly coincides with the Galena-St. Peter contact or the contact between the Galena and overlapping Pennsylvanian strata.

Regional Relations.—The upland in Illinois is on the backslope of a broad cuesta which rims the Wisconsin arch in eastern and southern Wisconsin and on the west extends northward through the northwest corner of Iowa into Minnesota.[6] Over most of the area the surface is submaturely eroded with restricted areas that are gently rolling. It is only along the Mississippi River that the upland is deeply dissected.

Rock Structure.—The uplands are developed primarily on the Galena dolomite and secondarily, along the margin, on the overlying Maquoketa shale. In general the slope of the upland is less than the dip of the beds, so that the surface bevels both formations and seldom coincides with the top of the Galena formation. The total thickness of the Galena-Platteville unit ranges from 300 to 375 feet and that of the Maquoketa from roughly 100 to 200 feet. Along the major bedrock valleys and locally on structural uplifts, erosion has exposed older rocks, from youngest to oldest, the Platteville dolomite, the St. Peter sandstone, the Prairie du Chien dolomite, and in a few places, the older Cambrian sandstones and dolomites (fig. 7).

Structurally the area is situated along the Wisconsin arch which plunges to the south at the rate of about six feet per mile (figs. 8 and 19). Over half the area is on the broad crest of the arch and its associated minor structures. The remaining portion is situated on the east and west flanks where the average strike is slightly west of north. The west limb of the arch has a steeper dip than the east limb and is interrupted by a secondary fold, the Savanna anticline. This anticline trends east-west through Mt. Carroll and Savanna in Carroll County and is responsible for the wedge of Galena Upland which extends westward and bisects the Silurian Upland. Structural relations in the southern part of the upland are complicated by the LaSalle anticline, the Sandwich fault zone, and the overlap of Pennsylvanian strata.

Topography.—The general trend and slope of the upland roughly coincide with the trend and plunge of the Wisconsin arch and the LaSalle anticline. However, there are important exceptions to this relationship, and it is unwarranted to conclude that the upland is a modified structural plane. Although the crest of the upland follows the structural axis in southern Ogle and northern Lee counties, northward it swings far to the west of the axis and southward the major topographic break to a lower surface in northern DeKalb County is apparently unrelated to structure. The eastward continuation of the upland onto the Maquoketa shale further emphasizes the lack of parallelism (figs. 18 and 19).[7]

The upland surface slopes southeastward from elevations of 1000 to 1050 feet in northern Jo Daviess County to elevations of 750 to 800 feet in central Lee and DeKalb counties. To the south the upland breaks down to a lower surface which has a general elevation of 600 to 650 feet above sea-level. Maximum relief on the bedrock surface occurs in Jo Daviess County where the total relief is about 900 feet and local relief is commonly more than 500 feet. Charles Mound in the northern part of the county has an elevation of 1241 feet above sea-level and is the highest point in the State. In the central part of the Galena

[6]The upland in Wisconsin was named the "Galena-Black River Upland" by Martin, in "Physical geography of Wisconsin," op. cit., fig. 12, p. 37. In the Driftless Section as a whole, N. M. Fenneman refers to it as the "Galena Upland," "Galena Cuesta," or "Galena Plain"; op. cit., pp. 525-26, 531-33.

[7]This problem is discussed further in connection with erosional history, p. 92.

Upland the amount of local relief diminishes to less than 300 feet, except near large bedrock valleys, and along the southern margin it is commonly about 150 feet.

The upland is maturely to submaturely dissected with the most deeply eroded areas lying along the Mississippi Valley in Jo Daviess and northern Carroll counties and north of Pecatonica Valley in Stephenson and Winnebago counties. Flattish to gently rolling upland tracts are broadly developed between major valleys, and the most conspicuous are found in northwestern Winnebago, northern Boone, and northern Lee counties. Along the southern edge of the upland in the Driftless Area, outliers of the retreating Niagara escarpment form prominent mounds which rise as buttes and small mesas above the upland level. These merge with a branchwork of narrow ridges capped by Silurian dolomite which broaden to the south. Many of the mounds have been named, of which the best known are Pilot Knob, Horseshoe Mound, Scales Mound, Charles Mound, and Benton Mound.[8]

Drainage Relations.—The western two-thirds of the upland is characterized by radial valley development from a central upland in western Ogle County (pl. 2). Secondary valleys slope eastward from this area to Upper Rock and Pawpaw valleys, southward to Princeton Valley, westward to the Upper Mississippi, and northward to Pecatonica Valley. The eastern third of the area is marked by three south trending valleys which outline two relatively narrow, south sloping ridges. The Upper Rock-Pawpaw and Troy bedrock valleys to the west are entrenched 300 feet into the upland and have cut down through the Galena dolomite into the St. Peter sandstone. For a distance of more than 50 miles these valleys are narrow, closely spaced, and remarkably parallel (pl. 1). Newark Valley to the east, which is underlain largely by Maquoketa shale, is relatively shallow and broad. It appears to be the only major valley in the region that can be related to the underlying bedrock.

Relation to Present Topography.—The relations of the Galena Upland to present physiographic divisions are shown by figures 3 and 9. The following types of topography are represented: 1) Bedrock topography of the Driftless Area (fig. 9, I); 2) bedrock topography modified by thin Illinoian drift (fig. 9, II); 3) eroded Illinoian drift-plains which reflect major uplands and valleys on the bedrock surface (fig. 9, IV); 4) aggraded bedrock valleys (fig. 9, III); 5) uneroded drift plains of the early Wisconsin (Shelbyville) Belvidere and Green River lobes which reflect only major features of the bedrock surface (fig. 9, VII); and 6) Bloomington and younger drift-plains and ridges which are contructional features and have no relation to the bedrock topography (fig. 9, VII).

The maturely dissected plateau in the Driftless Area constitutes one of the most rugged hill lands in the State. It includes parts of both the Galena Upland and the Silurian Upland of northwestern Illinois. The subdued uplands to the east, which are thinly covered by Illinoian drift, form a distinct physiographic unit enclosed on the south and east by the Wisconsin drift border. This area, again including part of the Silurian upland, has been termed the *Rock River Hill* Country[9] (fig. 3). The remaining part of the Galena Upland covered by Wisconsin drift is included within the *Bloomington Ridged Plain* and *Green River Lowland*.[10]

Silurian Upland in Northwestern Illinois

Definition.—The uplands in northwestern Illinois underlain by Silurian rocks are not sharply delimited from the Galena Upland except in the Driftless Area and for a short distance to the east where the Niagara escarpment is a prominent feature. The boundary on the north and east coincides with the Silurian-Maquoketa contact and on the south with the contact between the Silurian or Devonian beds and overlapping Pennsylvanian strata (figs. 6 and 7).

[8]Shown on the Galena and Elizabeth quadrangle maps.

[9]Leighton, M. M., Ekblaw, George E., and Horberg, Leland, Physiographic divisions of Illinois: Jour. Geology vol. 56, No. 1, pp. 16-33, 1948; Illinois Geol. Survey, Rept. Inv. 129, 1943.

[10]Idem.

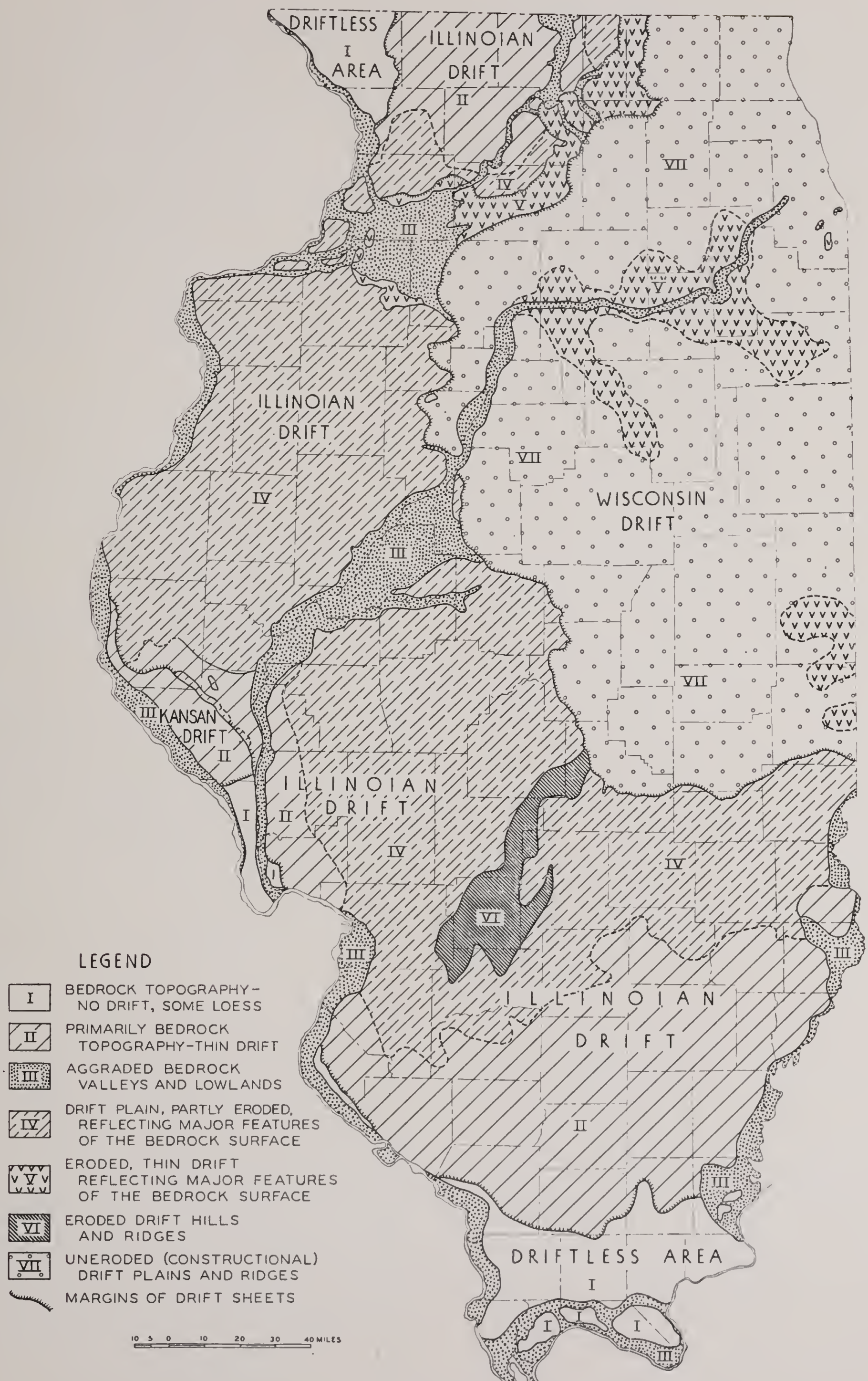

Fig. 9.—Distribution of glacial drifts in Illinois and the areas where present topography is influenced by bedrock topography.

Regional Relations.—The Silurian Upland can be traced beyond the Driftless Area northwestward into Iowa for a distance of about 70 miles where it is mantled by thin Nebraskan and Kansan drift. Beyond this point the Silurian is overlapped by the Devonian, and the escarpment continues into Minnesota on Devonian limestones. The scarp is 60 to 150 feet high and rises in elevation to the northwest. The broad back slope of the upland is largely drift-covered and has little influence on the present topography.

Rock Structure.—The Silurian rocks, including both the Niagaran and Alexandrian series, are composed entirely of dolomites which are predominantly massive and resistant to erosion (fig. 4). Cherty beds are abundant in many places and form the caprock for most of the mounds in the Driftless Area. Reef structures are present in the Racine and Port Byron dolomites, which comprise the upper part of the Niagaran, and in the vicinity of Port Byron there is some suggestion of klintar development. The Devonian limestones overlying the Silurian rocks form the bedrock in restricted areas along Rock and Mississippi valleys at the southwest tip of the area in northeastern Rock Island and northwestern Henry counties. They are not important elements in the bedrock surface because in most places they are overlapped by Pennsylvanian sandstones. The maximum thickness of the Silurian rocks in the area is about 400 feet and that of the Devonian about 100 feet.

The Savanna anticline in Carroll County divides the upland into two parts. North of the anticline the Silurian beds occur in a syncline which trends essentially east-west and plunges to the west; south of the anticline there is no reversal, and the beds dip rather steeply into the Illinois basin. In the southwestern part of the area a minor north-south trending anticline is responsible for the southward extension of Silurian rocks into southwestern Whiteside and Rock Island counties.

Topography.—The upland merges topographically into the Galena Upland, and there are no sharp boundaries between the two areas except along the escarpment in the Driftless Area. In the northern segment, from central Carroll County northward, both the escarpment and backslope are deeply eroded because of proximity to the deep Mississippi Valley. Over most of the area streams have cut down into the Maquoketa shales and Galena dolomite, leaving the Silurian capping the intervening ridges. The ridge crests slope southward across structure from elevations of more than 1100 feet to elevations of about 850 feet. The maximum relief on the bedrock surface is slightly over 800 feet.

The southern segment of the upland, south of central Carroll County, is lower and has less relief. It is maturely to submaturely eroded and slopes southward with structure from an elevation of about 750 feet in the northern part to less than 650 feet in northern Rock Island County. The maximum relief is about 450 feet.

As the result of glacial drainage diversions, two large island-like segments of the upland have been completely isolated by erosion (pl. 1). The northern Garden Plain upland[11] is located in western Whiteside County and is bounded by the Mississippi Valley on the west, Cattail Channel on the northwest, and Meredosia Channel on the south. Coe upland[12] to the south is in northern Rock Island County and is surrounded by Mississippi, Meredosia, and Pleasant bedrock valleys. Two smaller upland remnants along Mississippi Valley occur at Fulton and across the river two miles to the southwest at Clinton, Iowa.[13] There is also subsurface evidence that a buried rock hill may be present at the west end of Meredosia Valley opposite the mouth of the Wapsipinicon River (pl. 1).

Drainage Relations.—In preglacial time the drainage was westward into the Upper Mississippi Valley and southward into Princeton bedrock valley. Both valleys were then occupied by the ancient Mississippi which flowed eastward into the Illinois Valley. The tributary valleys have a general parallel orientation in a south-

[11]Carman, J. E., The Mississippi Valley between Savanna and Davenport: Illinois Geol. Survey Bull. 13, p. 3, 1909.
[12]Idem, p. 3.
[13]These features are well shown on the Cordova quadrangle map.

southwest direction which follows the regional slope of the upland ridges. In the northern segment of the upland this trend crosses structure, but in the southern portion the trend is down dip. The drainage pattern is anomalous in terms of normal cuesta development in that the major valley of the area transects the scarp and crosses the backslope and also because subsequent valleys are absent in the Maquoketa shale fronting the escarpment.

Relation to present topography.—The broad outlines of the present landsurface are reflections of the bedrock topography in varying degrees. The complexity of the relationship is shown in figure 9. Both the amount and sharpness of relief at present are less than they were in pre-Illinoian time. The major valleys have been aggraded to a level 200 feet or more above their bedrock floors, large tributary valleys have been buried by glacial drift, and the smaller irregularities of the uplands are concealed by till or thick deposits of loess. Princeton bedrock valley, except for its western part along the present Meredosia Channel, is now largely concealed by Wisconsin till and outwash and is not a major drainage way. In terms of present physiographic divisions, the upland falls within the Driftless Area, the Rock River Hill Country, and the Green River Lowland (fig. 3).

Pennsylvanian Upland in Western Illinois

Definition and Boundaries.—The Pennsylvanian Upland includes that part of the upland south of the Green River Lowland and west of the Illinois bedrock valley which is underlain by Pennsylvanian rocks (fig. 6). The northern and eastern boundaries are thus erosional, whereas the western boundary coincides with the overlapping contact between the Pennsylvanian and underlying Mississippian rocks. North of Hancock County the upland is not sharply delimited from the Meramec-Osage upland.

Rock Structure.—The upland is underlain entirely by Pennsylvanian beds except for restricted occurrences of older rocks along the lower parts of large bedrock valleys (fig. 7). The Pennsylvanian strata belong to the Caseyville, Tradewater ("Pottsville"), Carbondale, and lower McLeansboro groups[14] and comprise about 20 cyclical repetitions of beds or cyclothems (fig. 4). Each cyclothem if fully developed would include the following sequence, although at most localities some beds are absent:

10. Shale with ironstone concretions
9. Marine limestone
8. Black slaty shale
7. Impure lenticular marine limestone
6. Shale
5. Coal
4. Underclay
3. "Fresh-water" limestone
2. Sandy shale
1. Sandstone, locally unconformable on underlying beds.

These lithologies indicate the composition of the system as a whole, although in their relation to bedrock topography, the thicker units in the sequence, the lower sandstone and sandy shale (nos. 1 and 2) and the upper shale (no. 10) are most significant. In general the sequence is relatively weak and easily eroded. The basal sandstone (no. 1) and the upper marine limestone (no. 9) are the units most resistant to erosion. The maximum thickness of the Pennsylvanian in the area is about 500 feet with 0-150 feet within the Tradewater group, 65-160 feet within the Carbondale group, and about 180 feet within the McLeansboro group.[15] The coals, shales, and sandstones appear to thin and disappear toward the southwest with most of the thinning occurring within the Tradewater group.[16]

Structurally the area is situated along the northwest flank of the Illinois basin just east of the axis of uplift that separates the basin from the Forest City basin in Iowa (fig. 8). The regional dip is southeastward at the average rate of about 12 feet per mile. Minor folds tend to strike down-dip toward the deep part of the basin.

[14]Weller, J. M., Henbest, L. G., and Dunbar, C. O., "Stratigraphy of the Fusuline-bearing beds of Illinois" in Dunbar, C. O., and Henbest, L. G., Pennsylvanian Fusulinidae of Illinois: Illinois Geol. Survey Bull. 67, pp. 9-10, 13-16, 1942.

[15]Wanless, H. R., "Pennsylvanian cycles in western Illinois," *in* Papers presented at the Quarter Centennial Celebration of the Illinois State Geological Survey; Illinois Geol. Survey Bull. 60, p. 181, 1931.

[16]Wanless, H. R., Pennsylvanian section in western Illinois: Geol. Soc. America Bull. 42, pp. 803 and 805, 1931.

Topography.—The main crest of the upland trends southwestward parallel to Illinois Valley and slopes southward from an elevation of about 800 feet above sea-level in southeastern Henry County to an elevation of about 700 feet in Brown County. There are two prominent secondary ridges. One extends northwestward from northern Knox County into Rock Island County and the other lies east of Spoon River Valley in Peoria and Fulton counties. The highest bedrock elevation within the area, 825 feet above sea-level, occurs near Kewanee in Henry County and is about 475 feet above the major bedrock valley to the east. Local relief over most of the area is about 100 feet and may be double this amount along important bedrock valleys.

The interpretation of the bedrock surface indicates that the area is submaturely to maturely dissected, as were the uplands of northern Illinois, but unlike those areas the slopes are more gentle and the valleys are wider. Broad gently rolling upland surfaces appear to be present in southwestern Warren County and in northwestern Adams County. Erosional outliers of the upland resulting largely from glacial drainage diversions are present east of Illinois River near Peoria and in Rock Island and northern Henry counties. Only the Moline upland[17] in Rock Island County is an important feature of the present land surface.

The high elevation of the uplands on the older Paleozoic rocks in the northern part of the State is due in large part to the resistance of the underlying formations to erosion. This explanation, however, cannot account directly for the difference in elevation between the Pennsylvanian Upland and the Pennsylvanian Lowland to the east where there are no important differences in bedrock composition. Nor is there any marked difference in drainage position which could account for lower elevations in the northern third of the lowland (figs. 6 and 18). It is true that a major valley crosses the central part of the lowland, but it is equally true that major valleys essentially surround the Pennsylvanian Upland.

One of the important factors accounting for this difference in elevation is related to the higher structural position and diminished thickness of the Pennsylvanian strata, so that resistant Mississippian limestones floor the lower portions of most of the large valleys. The local baselevels provided by these resistant beds may have been effective in retarding erosion. Another possible explanation involves the age of the upland surfaces; if these are remnants of an ancient erosion surface, drainage conditions at the time of their development may have been greatly different than at present so that the primary causes for their differences in elevation are obscured.

Drainage Relations.—In preglacial or early glacial time the drainage of the upland was probably outward from the central upland crest (pl. 2). The southward slope of the upland, except in the northern part, appears to be reflected in the prevailing southwest and southeast trend of the main valleys. In the northern part of the district the valleys slope radially from the upland in southern Henry County. The valley pattern shows no important relations to structure or stratigraphy and suggests consequent drainage development on an upwarped erosion surface.

The preglacial and early glacial divide between east and west drainage followed the northwest branch of the central upland from Knox County into Rock Island County where it crossed the present Mississippi channel at Fairport, Iowa. Glacial advances, probably from both west and east at different times, caused erosion of spillways across divides. These are prominent features of the district and are well shown in northern Henry County, northeastern Mercer County, southeastern Knox County, western Fulton County, the Peoria region, and southwestern McDonough County (pls. 1 and 2).

Relation to Present Topography.—As shown by figure 9, most of the district lies within an eroded Illinoian drift-plain which in its gross features of major uplands and lowlands conforms to the bedrock surface.

[17]Carman, J. E., op. cit.

Sections of eroded drift-plain having no relation to bedrock topography are present over large buried valleys and along moraine belts.

The bedrock upland is an important element in determining the broad features of the *Galesburg Dissected Upland Plain*[18] of the present landsurface (fig. 3).

Pennsylvanian Lowland in Central Illinois

Definition and Boundaries.—This extensive lowland covers about three-fifths of the State and includes essentially all of the State underlain by Pennsylvanian rocks outside of the Pennsylvanian Upland (figs. 6 and 7). The southern boundary of the section follows the contact between the Tradewater and Carbondale groups of the Pennsylvanian system, and the western boundary from Randolph County north to the Pennsylvanian Upland coincides closely with the Pennsylvanian - Mississippian boundary. The boundaries north of this point were noted previously.

Four subdivisions of the bedrock lowland representing possible strath surfaces eroded below the general level of the district are: the Green River Lowland, Havana Lowland, Kaskaskia Lowland, and Wabash Lowland[19] (fig. 6).

Regional Relations.—The Pennsylvanian Lowland extends eastward into Indiana and beyond into the western Kentucky coal field. The present Wabash Lowland in Indiana, in large part, appears to be a continuation of this surface. South of the glacial boundary in Indiana the lowland is included in the Shawnee section of the Interior Low Plateaus of the present topography.

Rock Structure.—The "Coal Measures" which underlie the area are similar lithologically to those described in the Pennsylvanian Upland. They are dominantly weak shales which are easily eroded but include thin limestones, generally less than 25 feet thick, and locally developed sandstones which are more resistant to erosion. In a few cases these resistant units may be reflected in the bedrock surface. Thus the Shoal Creek limestone in southern Livingston and north-central Sangamon counties and the LaSalle limestone in southwestern Vermilion, southwestern Clark, and western Clay counties appear to underlie higher sections of the bedrock surface.

The entire district lies within the Eastern Interior coal basin which comprises about four-fifths of Illinois and adjacent parts of southwestern Indiana and western Kentucky. Within this area the regional dip is inward toward the deepest part of the basin which is located in southeastern Illinois near the intersection of Wayne, Edwards, and White counties (fig. 8).[20] The structural center of the basin is thus far to the south of the geographic center. The structural relief on the base of the New Albany shale from the edge of the basin to its center is over 5,000 feet, and the average regional dip of this horizon from northwest to southeast is about 20 feet per mile.

The principal structure within the basin is the LaSalle anticlinal belt which extends from the Wabash River north-northwest for over 200 miles to LaSalle County. Inliers of Mississippian, Devonian, and Silurian rocks occur along the structure in Ford, Champaign, and Douglas counties. Minor structures appear to trend either down regional dip or in a north-northeast direction.

Topography.—If the effects of latest valley erosion are disregarded, the surface of the northern two-thirds of the lowland as far south as Effingham County is found to be remarkably flat with uniform elevation between 600 and 650 feet above sea-level. In the southern one-third of the section the surface slopes southward from 600 feet to 500 feet above sea-level in a distance of about 75 miles. Two interstream areas rise above the general level to elevations of 700 feet above sea-level and

[18] Leighton, Ekblaw, and Horberg, op. cit.

[19] Malott, C. A., The physiography of Indiana: Part 2 of Handbook of Indiana Geology, pl. 2, p. 66, 1922.

[20] The deepest part of the basin lying between the LaSalle anticlinal belt on the east and the Duquoin anticline on the west is strictly the "Illinois basin," although this term has been used widely for the entire coal basin in Illinois. Bell, A. H., Subsurface structure of the base of Kinderhook-New Albany shale in central and southern Illinois: Illinois Geol. Survey Rept. Inv., 92, p. 7, 1943.

more; one is in northeastern McLean County and the other is in southern Edgar County (fig. 18). The highest bedrock elevation in the district, about 760 feet above sea-level, occurs in the latter area; the lowest elevations, about 220 feet above sea-level, are along Wabash bedrock valley. Thus the maximum total relief is about 540 feet.[21] The local relief is about 150 feet except near large valleys where it may reach 250 feet or rarely 300 feet.

In contrast with other sections, the topography of the Pennsylvanian Lowland is more subdued, streams are not so deeply entrenched, valleys are broader, and the valley walls more gently sloping. This seems to be due largely to the prevailing weak shales that form the bedrock and to low initial relief.[22] The interpretations of the subsurface data indicate that stream erosion of the bedrock reached the stage of mid-maturity prior to Illinoian glaciation, and that strath surfaces of an earlier cycle were widely developed along major drainage lines.

The position of major bedrock uplands is closely related to preglacial drainage, so that their crests normally lie along the center of interstream areas. On this basis these main upland ridges may be recognized: (1) A north-south upland lying north of Mahomet Valley and between the upper Illinois bedrock valley and Kempton Valley; (2) an east-west upland south of Mahomet Valley which crosses the central part of the State as a relatively continuous low ridge and formed the watershed between River Mahomet and drainage south into the Kaskaskia, Little Wabash, and Embarrass bedrock valleys; and (3) a low triangular upland in the southern part of the section between the Wabash and Kaskaskia lowlands (pl. 1).

The straths developed along the larger valleys are 50 to 150 feet below the general upland level and are best represented by the Green River, Havana, Kaskaskia, and Wabash lowlands (figs. 6 and 18). The Green River Lowland was eroded near the junction of Princeton and Pawpaw bedrock valleys at a time when the ancient Mississippi and Rock rivers respectively flowed in these valleys. The enlargement of the lowland appears to be in part cyclical and in part due to interglacial erosion. The western part of the lowland in particular seems to have been widened by the Mississippi during the Illinoian-Wisconsin interval. The broad Havana Lowland and its extensions upstream were developed at the junction of several important drainage lines and just above the point where massive Mississippian limestones cross the valley (figs. 5 and 7). These beds give rise to the narrows at Beardstown and provided a local baselevel above which the lowland could have developed by lateral planation. Local baselevels were also important factors in the development of the Kaskaskia and Wabash lowlands. In both valleys resistant lower Pennsylvanian sandstones and Mississippian limestones retarded downward cutting and caused marked constrictions of the valleys.

Drainage Relations.—In preglacial time the lowland was drained by three major streams: the preglacial Mississippi, Mahomet (Teays), and Wabash. The valleys in the northern part of the lowland converge toward Mahomet Valley; those in the southern part slope southeastward to the Wabash and southwestward to the lower Mississippi.

Bedrock channels resulting from glacial drainage diversions are not as apparent as they are in the Pennsylvanian Upland, although two of the most striking examples in Illinois occur near the north edge of the lowland. These two channels, Ticona and upper Illinois bedrock valleys, cross the preglacial upland between middle Illinois and Kempton bedrock valleys at a distance no more than ten miles apart (pl. 2). The older Ticona Valley is now completely buried, whereas the Illinois channel is occupied by the present river. Temporary glacial spillways, not so deeply eroded, appear to be present in western Sangamon,

[21]The use of the term "lowland," here used in a relative sense, may be open to question in the light of this figure. Strictly the section might appropriately be called a "plain," as much of the area was high enough above local baselevels to become incised.

[22]The best general picture of the bedrock topography is provided by the present landsurface in the southern fourth of the lowland where the drift is too thin to conceal the preglacial topography (Type II, fig. 9).

central Shelby, western Edgar, and central Marion counties (pl. 1).

Relation to Present Topography.—The outer boundary of the Wisconsin drift-sheet splits the lowland into two major physiographic categories: (1) In the northern half of the section the Wisconsin drift-sheet completely buries the bedrock surface; and (2) to the south the Illinoian drift-sheet reflects bedrock features to varying degrees in the present landscape (fig. 9).

The subdivision of the Illinoian drift-sheet into: (1) eroded drift-plain reflecting only major features of the bedrock surface; and (2) areas of thin drift in which the topography is primarily bedrock-controlled, is established on the basis of present physiographic contrasts and drift thicknesses. Smaller divisions include: (1) Areas of thin Wisconsin drift showing bedrock-surface control in LaSalle and Livingston counties and in Vermilion and Edgar counties; (2) eroded Illinoian drift ridges, largely in the Kaskaskia drainage basin; and (3) aggraded bedrock valleys along the Illinois, Mississippi, and Wabash rivers (fig. 9).

These areas coincide very closely with the present physiographic divisions (fig. 3) in which the Wisconsin drift-sheet is divided into the *Bloomington ridged plain* and the *Kankakee plain,* and the Illinoian drift into the *Springfield plain* and the *Mt. Vernon hill country.*[23]

The entire lowland was glaciated except for a small area in central Saline County.

Meramec-Osage Upland

Definition and Boundaries.—The buried limestone upland fringing the Mississippi in western Illinois is termed the *Meramec-Osage Upland* from the resistant Mississippian limestone which underlies it (fig. 6). The section is lower than the Lincoln Hills to the south and appears to be less dissected than the Pennsylvanian Upland to the east. The southern boundary of the upland is drawn at Carthage bedrock valley, south of which the Mississippian strata rise to form the central ridge of the Lincoln Hills. The eastern boundary, which follows the approximate margin of overlapping Pennsylvanian strata, is clearly defined by the Carthage Valley and its north tributary in Hancock County, but to the north an arbitrary boundary is drawn. The northern end of the upland terminates at the Burlington-Kinderhook contact and is marked by a bold upland nose which juts into the Mississippi Valley.[24] The upland continues across the Mississippi into Louisa County, Iowa, where a broad bedrock lowland was eroded in the Kinderhook shale north of the upland.[25]

Rock Structure.—Most of the upland is underlain by Meramec and Osage limestones which have an aggregate thickness of about 300 feet. In this series the resistant Burlington limestone, 70 to 100 feet thick, is most important physiographically (figs. 4 and 7).

The Mississippian rocks are brought to the surface along the broad north-south trending arch between the Illinois and Forest City basins (fig. 8). Prevailing dips are southeastward toward the center of the Illinois basin.

Topography.—The available data indicate that much of the section is flattish to gently rolling upland having an average elevation of about 650 feet above sea-level (pl. 1). Higher elevations, slightly over 700 feet, occur in the northern half of the area and appear to merge with bedrock ridges in the Pennsylvanian Upland to the east. Although the total maximum relief is about 375 feet, the local relief in most places is less than 100 feet. The lowest bedrock elevations, about 340 feet above sea-level, occur along the bedrock valley of the Mississippi.

Drainage Relations.—The preglacial drainage of the upland was westward into the Middle Mississippi (ancient Iowa) bed-

[23]Leighton, Ekblaw, and Horberg, op. cit. The boundary between the Springfield Plain and Mt. Vernon Hill Country is essentially the boundary shown in figure 9 between types II and IV and closely approximates a similar division made by Paul MacClintock *in* Physiographic divisions of the area covered by the Illinoian drift-sheet in southern Illinois: Illinois Geol. Survey Rept. Inv. 19, Pt. 1, fig. 1, p. 28, 1929.

[24]"Bald Bluff" on the Keithsburg quadrangle map.

[25]Udden, J. A., Geology of Louisa County: Iowa Geol. Survey Ann. Rept. 1900, vol. 11, pl. IV, op. p. 96, 1901.

rock valley, much as it is at present, although entirely different drainage systems were involved (pl. 2). The two largest preglacial valleys, Carthage and Kirkwood, which head in the Pennsylvanian Upland and extend westward across structure to the Mississippi, appear to be antecedent or superimposed.

Relation to Present Topography.—The bedrock upland is completely concealed by Illinoian drift and is related only indirectly to present topography. The major preglacial valleys, Carthage and Kirkwood, were both buried by glacial drift.

The broad upland aspect and slope of the preglacial land surface, however, is carried over into the present till-plain which forms a part of the *Galesburg Dissected Upland Plain* (figs. 3 and 9).

ESSENTIALLY PRESENT PHYSIOGRAPHIC DIVISIONS

In contrast with preceding physiographic divisions which, except for small areas, are entirely buried by glacial drift, the sections described below coincide closely with present physiographic divisions and are essentially driftless (fig. 6). The variations between preglacial and present boundaries (figs. 3 and 6) are due to the fact that the present boundaries of the Interior Low Plateaus and Ozark Plateaus are determined largely by the margin of the Illinoian drift, whereas the preglacial boundaries are determined by the bedrock topography.

Lincoln Hills

Definition and Boundaries.—The bedrock ridge underlain largely by Mississippian limestones which extends southeastward from northern Adams County into Calhoun and Jersey counties is closely related to the Lincoln fold and considered to be a part of *Lincoln Hills section* of the Ozark Plateaus (figs. 3 and 6).[26]

The eastern boundary of the preglacial division coincides closely with the Mississippian-Pennsylvanian contact, and the southern boundary follows the Cap au Grés faulted flexure at the south margin of the uplift. The present boundary of the section coincides with the preglacial boundary on the south but differs from it on the east, and especially on the north where drift-controlled topography is excluded. The upland as a whole, bisected by the Mississippi River, continues into northeastern Missouri where the most rugged topography is developed on Ordovician dolomites along the axis of the fold.

Rock Structure.—The upland is underlain for the most part by limestones and shales of the Osage group which have a total thickness of about 200 feet and in which the Burlington limestone is most important physiographically. Argillaceous beds of the underlying Kinderhook series occur along the larger valleys in Calhoun and Pike counties, and older Paleozoic strata of Ordovician, Silurian, and Devonian age are exposed along the Cap au Grés flexure to the south (fig. 7).

The area is structurally a part of the northeast flank of the Ozark dome and is dominated by two sub-parallel folds, the Lincoln and the Pittsfield-Hadley anticlines, which have a general northwest trend. The south end of the Lincoln fold is transected by the Cap au Grés faulted flexure which extends slightly north of west through southern Calhoun and Jersey counties (fig. 8). The outlines of the Lincoln Hills, both in Missouri and in Illinois, are determined largely by these structures.

Topography.—As most of the upland is driftless except for loess deposits or has but a thin cover of drift, the bedrock is well shown on topographic maps.[27] In preglacial time the principal physiographic feature was a central ridge extending throughout the length of the section (pl. 1) as at present. This ridge ranges in elevation from 650

[26]In recognizing this section the writer departs from established usage and follows W. W. Rubey who pointed out that this area, generally considered part of the present Till Plains section, is genetically and topographically more closely related to the Ozarks than to the Central Lowland and suggested that the name "Lincoln Hills section" of the Ozark Plateaus be applied to it; Geology and mineral resources of the Hardin-Brussels quadrangles: U. S. Geol. Survey unpublished manuscript, 1931. This is a modification of the "Lincoln Ridge district" of E. M. Shepard, Underground waters of Missouri; their geology and utilization: U. S. Geol. Survey Water-Supply Paper 195, pp. 8, 10-11, 1907.

[27]Mt. Sterling, Liberty, Quincy, Hannibal, Barry, Pittsfield, Pearl, Nebo, Hardin, Brussels, and St. Charles quadrangles.

to almost 800 feet above sea-level, the average elevation being about 700 feet. A maximum total relief of 525 feet is found in Calhoun County where the upland is 800 feet above sea-level and the rock floor of the Illinois Valley is about 275 feet above sea-level.

Most of the section appears to be maturely dissected and much of it, especially to the south in Calhoun County, is deeply eroded into rugged hill country with sharp youthful valleys. Restricted areas of flattish to gently rolling upland are present along the crest of the central ridge.

Drainage Relations.—The central ridge formed the preglacial divide between the Mississippi and Illinois bedrock valleys except for two valleys which cross the ridge to enter the Mississippi bedrock valley. One of these preglacial valleys is that of Mill Creek in central Adams County and the other is that of Bay Creek in southern Pike County.

Salem Plateau

Definition and Regional Relations.—The Salem Plateau section of the Ozark Plateaus is widely developed in Missouri, but only small segments isolated by the Mississippi are present in Illinois (figs. 3 and 6). The area includes that part of the "Illinois Ozarks" which is structurally and topographically part of the Ozark dome. In the northern segment of the plateau an arbitrary boundary with the Shawnee Hills is drawn where clastic rocks forming the Pennsylvanian escarpment give way to finer sediments and the escarpment disappears. The eastern margin of the segment closely follows the overlapping edge of the Pennsylvanian strata, and the northern boundary with the Lincoln Hills coincides with the Cap au Grés fault.[28] The southern segment of the plateau in Union and Pulaski counties, underlain largely by Devonian cherts, is delimited from the Shawnee Hills to the east along the contact between Carboniferous and older rocks.

[28]Inclusion of the northern segment in the Salem Plateau represents a modification of Fenneman's classification in which this area was included within the Till Plains section: Physiography of Eastern United States, pl. VI. McGraw-Hill, N. Y., 1938.

Northern Segment.—The northern segment of the plateau lies on the backslope of Meramec-Osage Upland which flanks the Ozark uplift on the north and east. It is underlain by Meramec limestones, about 500 feet thick, and sandstones, limestones, and shales of the Chester series which reach a total thickness of about 700 feet. Regional eastward dips are disrupted in the northern half of the area by the Valmeyer and Waterloo anticlines which parallel the edge of the Illinois basin (fig. 8).

As in the Lincoln Hills, the most prominent topographic feature is a central ridge which rises to a maximum elevation of more than 700 feet in Monroe County (pl. 1).[29] The ridge forms the watershed for tributary drainage, but the Mississippi and Kaskaskia rivers cross the ridge without regard to structure. Karst topography, developed primarily on the St. Louis limestone of the Meramec group, is present in Calhoun, St. Clair, and Monroe counties.[30]

Southern Segment.—The formations exposed in the southern segment range in age from the Kimmswick limestone of the middle Ordovician to the Upper Devonian Mountain Glen shale and are composed dominantly of limestone (figs. 4 and 7). A thick succession of deeply weathered Devonian chert and cherty limestone formations underlie the plateau surface. Along the southern edge of the plateau in Alexander and Pulaski counties, Cretaceous and Tertiary sediments overlap the Paleozoic rocks. The area is within the Ozark structural province previously noted and includes a zone of north-south and northwest-southeast folds and faults.[31]

A clearly defined physiographic boundary separates the plateau from the Shawnee Hills to the east. The contrast is marked by more rugged topography, closer drainage texture, absence of structure control, and

[29] Shown on the Waterloo, Kimmswick, Crystal City, Renault, Baldwin, and Chester quadrangle maps.

[30]Shown on the Hardin, Brussels, Waterloo, and Renault quadrangle maps.

[31]Weller, J. M., Geology and oil possibilities of extreme southern Illinois: Illinois Geol. Survey Rept. Inv. 71, pl. 1, 1940.

Weller, J. M. and Ekblaw, George E., Preliminary geologic map of parts of the Alto Pass, Jonesboro, and Thebes quadrangles: Illinois Geol. Survey Rept. Inv. 70, pp. 25-26, 1940.

higher elevations in the plateau section.[32] The highest bedrock elevation, 1030 feet above sea-level, is on Bald Knob near the north edge of the section. The lowest elevations, about 190 feet above sea-level, are along the Mississippi Valley, giving a total maximum relief of more than 800 feet. Local relief ranges from 200 to 400 feet. The plateau is maturely dissected by branchworks of youthful valleys. Small remnants of a flat upland surface occur at elevations 600 to 800 feet above sea-level.

The northern half of the section is drained by streams which head in the Shawnee Hills and flow westward across the plateau into the Mississippi; in the southern part a central divide separates Mississippi and Cache Valley drainage.

The plateau is unglaciated but the bedrock topography has been modified by the deposition of loess over the entire area and by alluviation of both major and tributary valleys. The fill of glacial outwash and alluvium in Mississippi and Cache valleys is about 150 feet thick, so that present relief is considerably less than preglacial or early glacial relief.

Shawnee Hills

Definition and Boundaries.—The Shawnee Hills division is a modification of the Shawnee Hills section of the present landsurface. The boundaries are the same except on the north where the preglacial division is bounded by the inner margin of the lower Pennsylvanian (Caseyville) cuesta rather than the edge of the Illinoian drift (figs. 3 and 6). Only the northern edge of the section in Randolph, Jackson, and Williamson counties was glaciated. The remaining boundaries are fixed by the contact between Carboniferous and older or younger strata. The section is part of a region which has long been popularly called the "Illinois Ozarks."

Regional Relations.—The western limits of the section are within Illinois, but to the east the upland on Chester strata and lower Pennsylvanian sandstones continues into Kentucky and finally loops back north into southern Indiana.

[32]Shown on the Alto Pass, Jonesboro, and Thebes quadrangle maps.

Rock Structure.—Chester strata composed of sandstone and limestone-shale formations are the dominant bedrock and underlie most of the southern part of the area (figs. 4 and 7). Some sandstones are important cliff-formers, otherwise the beds are only moderately resistant to erosion. Meramec and Osage limestones are present in the southwest corner of the section, and strata ranging in age from Upper Devonian to Lower Pennsylvanian occur in the vicinity of Hicks dome in Hardin County. The Pennsylvanian escarpment which crosses the northern part of the section is underlain by sandstones and shales of Caseyville and Tradewater age. The total thickness of the Mississippian is about 3000 feet, with half belonging to the Iowa series (Meramec and Osage) and half to the Chester series; the Pennsylvanian beds are about 1000 feet thick.

Structurally the section is situated along the south rim of the Illinois basin so that the strike of the beds forms a southward loop and the regional dip is northward. This pattern is disrupted by two complex zones of faulting and folding which to a varying degree involved a major part of the area (fig. 8).

The most intensive disturbance occurred in Gallatin and Hardin and adjoining parts of Saline and Pope counties, centering around Hicks dome. It is characterized by complex northeast trending faults and folds associated with basic intrusives and mineralized veins. The northern margin of the disturbed area is marked by the Shawneetown-Rough Creek fault which has a maximum displacement of at least 3500 feet.[33] Hicks dome in western Hardin County is the largest and most prominent structure in the area.

The second structure zone delimits the western edge of the section and is part of the Ozark structural province. It is characterized by north and northwest trending folds and subordinate faults.[34]

Topography.—Like the other driftless or

[33]Butts, Charles, Geology and mineral resources of the Equality-Shawneetown area: Illinois Geol. Survey Bull. 47, p. 59, 1925.

[34]Weller, J. M., Geology and oil possibilities of extreme southern Illinois: Illinois Geol. Survey Rept. Inv. 71, pl. I, 1940.

essentially driftless areas, the Shawnee section is a relic landsurface held over from preglacial or early glacial times. Bedrock erosion appears to have been essentially completed before the Illinoian ice invasion. Subsequent modifications of the topography are minor and resulted from deposition of thin till at the northern edge of the section, wind-blown loess over the entire landsurface, and outwash and alluvial materials along both main valleys and tributaries. Local channels were eroded in the bedrock as the result of drainage changes.

The physiographic features of the region fall naturally into two divisions: (1) The Pennsylvanian escarpment on the north; and (2) a dissected plain on the south underlain by Mississippian strata (fig. 5). The highest bedrock in the section occurs near the east end of the Pennsylvanian escarpment at an elevation of about 1050 feet above sea-level. The bedrock floors of the large valleys are less than 200 feet above sea-level, which gives a total relief of more than 850 feet.

The Pennsylvanian escarpment enters the State from the southeast near Shawneetown in southern Gallatin County where prominent ridges[35] are developed on the Caseyville sandstone. From the Shawneetown area the crest of the ridge continues west through northern Pope and Johnson counties to Union County where it swings north and becomes drift-covered in Jackson and Randolph counties.[36] In most areas the ridge is composite in that one or more resistant sandstones above the main Caseyville sandstone form separate escarpments and locally underlie the ridge crest. Elevations along the ridge crest are between 700 and 750 feet above sea-level in most places, although Williams Hill in northwestern Pope County has an elevation of 1065 feet above sea-level and is the highest point in the State outside of the Driftless Area in northwestern Illinois. The ridge is maturely dissected by youthful valleys and commonly has a local relief of 200 feet or more. Remnants of a flat upland surface are preserved on many narrow ridge crests throughout the length of the escarpment.

The uplands of the Mississippian plain have a general elevation of 500 to 550 feet below which valleys, now aggraded, have been eroded to a depth of 200 feet or more. The region is maturely eroded and has only small patches of flat upland along divides. Differential erosion of the resistant and weak formations of the Chester series has given rise to numerous minor escarpments, structural benches, fault-line scarps, and subsequent valleys. Fault-line scarps are conspicuous features in the vicinity of Dixon Springs in western Pope County.[37] Karst features developed on the St. Louis limestone are present near Cave in Rock, Hardin County, and in south-central Union County.[38]

Drainage Relations. — The Pennsylvanian escarpment forms a watershed extending completely across the southern part of the State. Drainage northward is by numerous short tributaries into the subsequent valleys of Crab Orchard Creek and South Fork of Saline River. Streams south of the divide flow across the Mississippian plain into Cache Valley which is an abandoned channel of the Ohio River.

Coastal Plain

Definition.—The Coastal Plain in Illinois includes the southern tip of the State underlain by unconsolidated Cretaceous and Tertiary sediments deposited in an embayment of the Gulf of Mexico (fig. 7).

Rock Structure.—The Coastal Plain sediments overlap the older Paleozoic rocks and have a total maximum thickness of about 785 feet. The following units have been recognized:[39, 40]

[35]Shown on Shawneetown and Equality quadrangle maps. These escarpments, represented by "Gold Hill," "Wildcat Hill," and "Cave Hill," are not to be confused with the "Shawneetown Hills" to the north which are erosion remnants of McLeansboro strata.

[36]The south-facing scarp is well shown on the Carbondale quadrangle map.

[37]Shown on the Shawneetown, Equality, Vienna, and Brownfield quadrangle maps.

[38]Shown on the Fords Ferry and Dongola quadrangle maps.

[39]Cooper, C. L., Smaller foraminifera from the Porters Creek formation (Paleocene) of Illinois: Jour. Paleo., vol. 18, p. 345, 1944; Illinois Geol. Survey Rept. Inv. 98, 1944.

[40]Weller, J. M., Geology and oil possibilities of extreme southern Illinois, op. cit., p. 43.

	Thickness ft.
Cenozoic	
Tertiary	
Pliocene system	
"Lafayette" gravel and sand....	50
Eocene system	
Wilcox group	
Sand, clay, and gravel........	300
Paleocene system	
Midway group	
Porters Creek clay and Clayton sand.....................	135
Mesozoic	
Cretaceous system	
Gulf series	
McNairy sand and clay.........	300

McNairy sand underlies most of the upland south of Cache Valley, the Eocene formations being restricted to the southwest corner of the upland in Pulaski County. Underlying Mississippian rocks are locally exposed in the eastern part of the area. The "Lafayette" gravel caps most of the hills and ridges, indicating that most of the bedrock erosion occurred subsequent to its deposition in Pliocene (?) time and before the Illinoian glaciation. These time limits are restricted further by evidence of deep weathering of the "Lafayette" and older deposits prior to erosion and loess deposition. Most of the bedrock erosion thus appears to have been accomplished in the latter part of the "Lafayette"-Illinoian interval in late Pliocene or early Pleistocene time.

Topography and drainage.—Three subdivisions of the Coastal Plain are recognized: (1) and (2) The coextensive alluvial plains of the Cache and Mississippi valleys; and (3) the Cretaceous hills (figs. 5 and 6). The alluvial plains are characterized by terraces and recent flood-plain features developed in post-Wisconsin time. The island-like Cretaceous hills are surrounded by the Cache, Ohio, and Mississippi valleys. Outwash and alluvium extend far up tributary valleys so that the upland is partially buried and certain segments are essentially isolated.

The total maximum relief on the bedrock surface is about 440 feet with the highest elevation (about 600 feet above sea-level) in the eastern part of the Cretaceous hills and the lowest elevation (about 160 feet above sea-level) in the Mississippi Valley west of Cairo. The average local relief is less than 100 feet. The upland is maturely eroded into a rolling hill-land of gently sloping knolls and ridges.

CHAPTER 4—BEDROCK VALLEY SYSTEMS

BEDROCK EROSION

The main period of bedrock erosion in Illinois occurred prior to the Kansan glaciation, and most of the major valleys were deeply entrenched by this time. In west-central Illinois the presence of Nebraskan drift within these valleys and their tributaries indicates that here, at least, entrenchment had been completed in preglacial time, although not necessarily in pre-Pleistocene time.[1] Although there is evidence in the Driftless Area that major down-cutting occurred during the interval between the Nebraskan and Kansan glaciations,[2] the regional significance of this period of erosion is uncertain. It may be assumed that the valley systems described below are preglacial in age unless otherwise stated.[3]

Outside the Wisconsin drift border the preglacial drainage systems in Illinois were much the same as present drainage lines (pl. 2). The Mississippi Valley, except for local rock gorges, was largely eroded in preglacial time. This is also true of the middle and lower Illinois, upper Rock, the Kaskaskia, the Muddy, the Saline, the Little Wabash, the Embarrass, the Wabash itself, and many important tributary valleys. However, in many of the valleys there have been important modifications, so that major valleys once connected are now separate, and the valleys now in use are combinations of older drainage lines. Throughout the area covered by Wisconsin drift, preglacial drainage lines were so completely buried that the present streams are of an entirely new generation.

As a result of combined Wisconsin and Illinoian glaciation, the Mahomet Valley system and its tributaries that extended into the northeastern part of the State were completely obscured, the ancient Mississippi was diverted from Princeton Valley and Illinois Valley to its present course, Rock River was shifted westward from Pawpaw Valley to its present position, and the entire Lake Michigan drainage system was buried by drift. These sweeping changes were accompanied by numerous secondary and temporary diversions of drainage. The record is complex and many questions are left unanswered.

The almost complete lack of structural control in the development of the preglacial drainage pattern is a notable feature and has important physiographic implications. This feature, perhaps more than any other line of evidence, indicates that the valleys inherited their positions from a landsurface on which structural and lithologic trends had been effaced. This condition would be possible only if the area had been reduced by erosion to a surface of low relief slightly above baselevel or if the Paleozoic rocks now comprising the bedrock had been covered unconformably by unconsolidated sediments. Following uplift of the older landsurface, the present valleys were superposed across the structure of the region.

As the following descriptions of bedrock valleys, together with previous descriptions of the preglacial physiographic districts, will form the basis for an interpretation of drainage history, it should be kept in mind that the bedrock-surface map itself, upon which descriptions are based, is an interpretation as well as a compilation of the data.

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[1]See pp. 69, 70.

[2]Trowbridge, A. C., Kansas Geological Society Guidebook, Ninth Annual Field Conference, Upper Mississippi Valley, pp. 62, 75, 1935.

[3]This conclusion differs from the interpretations of H. N. Fiske, Geological investigation of the alluvial valley of the lower Mississippi River: Mississippi River Comm., War Dept., Corps of Engineers, U. S. Army, pp. 67-70, 1944, who believes that the deep bedrock valley of the lower Mississippi was eroded during the Wisconsin glacial stage and that preglacial drainage was northward into the Great Lakes region. The data in support of the writer's conclusions are given in the pages which follow. However, no attempt is made in the present report to evaluate Fiske's evidence which was not received until the present study was essentially completed.

BEDROCK VALLEYS ENTERING LAKE MICHIGAN BASIN

Location and Regional Relations

The preglacial Lake Michigan drainage system is represented by several important valleys and numerous tributaries which extend down the backslope of the Niagara cuesta (pl. 1). Beyond the lake shore the valleys doubtless entered a large trunk valley that was eroded in the weak Devonian shales which underlie the lake. The probable existence of a major preglacial stream in the Lake Michigan basin has been postulated from the time of the earliest studies of the Great Lakes basins and is supported by the size, trend, and elevations of the bedrock valleys entrenched on the backslope of the cuesta. A similar buried drainage system, with perhaps shorter and somewhat smaller valleys, is present on the Niagara cuesta in southeastern Wisconsin for at least 100 miles north of the state line.[4]

Description

Most of the valleys head near the crest of the cuesta and flow eastward down dip or diverge slightly to the northeast. There are five important valleys, two of which enter the lake in Lake County and the others in northern and central Cook County. As compared with valleys in other uplands, these valleys are relatively broad and shallow and have low gradients. They pass below the present shore of Lake Michigan at elevations about 450 feet above sea-level.

The glacial drift below which the valleys are now buried consists largely of Wisconsin till belonging to the Valparaiso, Tinley, and Lake Border moraines and of Lake Chicago deposits. Older Illinoian (?) deposits are encountered locally. They are known to be present in McHenry County, Kane County, and in Hadley Valley in northeastern Will County, and may be represented also by the hard brown tills east of Blue Island, north of Harvey, in the Streeterville district, and near Evanston.[5]

[4]Alden, W. C., The Quaternary geology of southeastern Wisconsin: U. S. Geol. Survey Prof. Paper 106, pl. II, pp. 126-128, 1918.

[5]Otto, G. H., An interpretation of the glacial stratigraphy of the City of Chicago: unpublished doctor's thesis, University of Chicago, 1942.

Glacial Spillways

Two spillways breach the preglacial divide in northeastern Will County at relatively low elevations. One is the well-known Lake Chicago outlet past Lemont and the other is buried Hadley Valley located seven miles to the south (pl. 2).

The low bedrock sag at Lemont appears to have been eroded originally in pre-Wisconsin time. Later it was filled with Lemont drift of Tazewell (?) age and re-excavated prior to Valparaiso glaciation.[6] The Valparaiso drift did not completely fill the valley so that it continued to function during the various stages of Lake Chicago. The spillway was eroded to a depth of about 575 feet above sea-level.

Hadley Valley is of unusual interest because it suggests the existence of an ancestral Lake Chicago of pre-Wisconsin age whose waters discharged across the divide through a spillway 50 feet lower than the Lake Chicago outlet. As the valley contains a thick fill of Illinoian (?) outwash with some till, it is believed that the first diversion of drainage occurred during the Kansan ice advance and that it continued to function until the closing stages of the Illinoian glaciation.

Temporary spillways along which there was no important bedrock erosion doubtless existed elsewhere at low points along the preglacial divide during various glacial stages.

ANCIENT MISSISSIPPI SYSTEM IN NORTHERN ILLINOIS

Location and Regional Relations

During preglacial time northwestern Illinois was drained by two major river systems, the ancient Mississippi and the ancient Rock. The ancient Mississippi River occupied the upper Mississippi bedrock valley south to the present upper rapids in northern Rock Island County where it turned southeastward through buried Princeton Valley to the "Big Bend" of

[6]Bretz, J H., Geology of the Chicago region: Illinois Geol. Survey Bull. 65, Pt. 1, pp. 52-53, 1940.

present Illinois River near Hennepin. Below Hennepin the course was along the present middle Illinois Valley as far south as the Peoria region where it turned southeast and followed buried Mackinaw Valley to its junction with Mahomet Valley in southern Tazewell County (pl. 2). Except for the Mackinaw Valley section this is the course originally proposed by Leverett[7] and adopted by numerous subsequent writers.

In preglacial time, as now, the Mississippi drainage basin covered extensive areas in western Wisconsin, southeastern Minnesota, and northwestern Iowa. The preglacial valley seems to coincide with the present valley north of the present upper rapids to the vicinity of St. Paul, beyond which it is buried by drift.[8] An alternative view[9] that the preglacial upper Mississippi flowed northward from a divide near the mouth of the Wisconsin River has not been followed by more recent workers. The structure of the region suggests that the northeast tributaries flowing down-dip were probably longer than those entering the main valley from the west, which probably headed along the Niagara escarpment. Bedrock valleys along the lower Maquoketa and Wapsipinicon rivers seem to have been the two major tributaries that entered the Illinois section of the valley from eastern Iowa.

UPPER MISSISSIPPI VALLEY

Description

The upper section of the ancient Mississippi, as noted, is represented by the present valley above the upper rapids which begin at Cordova in northern Rock Island County.[10] The valley is eroded largely in the resistant Galena-Platteville and Silurian dolomites and is relatively narrow and steep-walled (pl. 1). The average width is about 2 1/2 miles with a range of from 1 to 7 miles. A notable widening of the valley for a distance of 15 miles above Savanna is due to erosion along the strike of the Maquoketa shale (fig. 7). The unusual width of the valley in the Silurian dolomite between Savanna and Fulton, however, cannot be explained by the weakness of the underlying bedrock and may be due to crowding of the river against the west valley wall by the Illinoian ice. This interpretation is in agreement with the Illinoian drift boundary and is shown in plate 1, although there are no available records which provide bedrock elevations in this portion of the valley.

Bedrock elevations along the valley determined from well records[11] are shown in table 2. The unusually low elevation of bedrock at Dubuque, Iowa, less than 300 feet above sea-level, is of special interest because it suggests the presence of a deep and narrow bedrock channel along the valley which elsewhere is not indicated by the subsurface data now available.

The valley-fill ranges in thickness from about 140 to possibly 340 feet and is composed dominantly of sand and gravel with minor amounts of silt and clay. There is no direct evidence from the available well records as to the ages of the deposits in the valley, but on the basis of glacial history and records in other sections of the valley it is probable that the fill is composed of alluvium[12] and Wisconsin outwash, underlain by older deposits.

The valley is transverse to major structures in the area and crosses the structure contours at essentially right angles (fig. 19). The Niagara escarpment is crossed in Jo Daviess County and again in Carroll County without affecting the course of the valley. The short stretch of valley in Maquoketa shale above Savanna, noted above, is incidental to the fundamental regional relation.

[7]Leverett, Frank, The preglacial valleys of the Mississippi and its tributaries: Jour. Geology, vol. 3, pp. 744-45, 1895.

[8]Leverett, Frank, Outline of Pleistocene history of Mississippi Valley: Jour. Geology, vol. 29, p. 615, 1921.

[9]Hershey, O. H., The Physiographic development of the Upper Mississippi Valley: Am. Geologist, vol. 20, pp. 264-68, 1897.

[10]Shown on the Lancaster, East Dubuque, Galena, Miles, Savanna, and Cordova quadrangle maps.

[11]It is always uncertain whether bedrock elevations determined from well records are in the deepest part of the bedrock valley, except in special cases where numerous test-borings have been made.

[12]Records of borings along the Mississippi, Illinois, and Wabash valleys indicate that alluvial materials are normally 40 to 60 feet thick, which may represent the maximum depth of scour during flood stage.

Table 2.—Bedrock Elevations Along the Ancient Upper Mississippi Valley

Location	Distance, miles	Present ground surface, feet above sea-level	Bedrock, feet above sea-level	Drift thickness, feet
Upper Mississippi Valley				
Dubuque, Iowa	0	625	[a]285	340
Dubuque, Iowa	0	600	[b]453	147
Mouth of Apple River, Carroll County	28	622	439	183
Sabula, Iowa	26	590	[b]429	161
Fulton, Whiteside County	16	600	[b]400	200
Clinton, Iowa	3	580	[c]375	205
Section 34, T. 21 N., R. 2 E., northern Rock Island County	6	570	376	194
Buried Princeton Valley				
Erie, Whiteside County	14	585	[d]418	167
Section 8, T. 17 N., R. 6 E., northwestern Bureau County	20	620	402	218
Princeton, Bureau County	20	700	328	372
Section 21, T. 15 N., R. 9 E., southern Bureau County	7	640	[e]340	300
Middle Illinois Valley				
Bureau, Bureau County	5	485	325	160
Hennepin, Putnam County	3	503	273	230
Putnam, Putnam County	5	540	[f]340	200
Henry, Marshall County	6	460	356	135
Buried Mackinaw Valley				
Section 8, T. 25 N., R. 3 W., northern Tazewell County	24	710	323	387
Section 28, T. 24 N., R. 2 W., eastern Tazewell County	10	675	295	380
Delavan, southern Tazewell County	15	610±	[g]288	322±

[a] This record, based on a study of well cuttings, is in agreement with a bedrock elevation of 279 feet above sea-level reported by A. C. Trowbridge, Erosional history of the Driftless Area: Univ. of Iowa Studies, vol. 9, no. 3, p. 118, 1921.
[b] Leverett, Frank, The Illinois glacial lobe: U. S. Geol. Survey Mon. 38, p. 475, 1899.
[c] Norton, W. H., Underground water resources of Iowa: Iowa Geol. Survey, vol. 21, p. 470, 1912. Other records are in the files of the Illinois Geological Survey.
[d] Habermeyer, G. C., Public groundwater supplies in Illinois: Illinois Water Survey, Bull. 21, p. 209, 1925.
[e] Leverett, op. cit., p. 633.
[f] Idem, p. 501.
[g] Savage, T. E., On the geology of Champaign county: Trans. Illinois Acad. Sci., vol. 23, p. 444, 1931.

Tributaries

Parallel tributary valleys head along the crest of the Galena upland and extend southwestward to join the main valley in normal dendritic fashion. The valleys are youthful and steep-walled and have depths of more than 200 feet in most places. From north to south the important tributaries on the Illinois side of the river are: Sinsinawa River, Galena River, Apple River, Rush Creek, Plum River, Johnson Creek, and Otter Creek. The glacial drift is thin or absent except for loess over most of the drainage basin so that the valleys have continued from preglacial time to the present with minor modifications. As the valleys are part of the present landsurface and are well shown on topographic maps they are not described in detail.

Drainage Changes

Apple River Valley.—The accession of headwater drainage by Apple River through piracy was first noted by Frank Leverett[13] and later described in detail by Trowbridge and Shaw.[14] The barbed headwaters and adjoining canyon in northeastern Jo Daviess County (pls. 1 and 2) are striking physiographic evidences of the change and are clearly shown on the Elizabeth quadrangle map. Diversion was caused by the Illinoian ice, which dammed the headwaters of preglacial Yellow River, causing them to spill over a low point in the divide into the head of Apple River to the southwest. A narrow canyon, more than 100 feet deep and about

[13] The Illinois glacial lobe: U. S. Geol. Survey Mon. 38, p. 477, 1899.
[14] Geology and geography of the Galena and Elizabeth quadrangles: Illinois Geol. Survey Bull. 26, pp. 95-99, 1916.

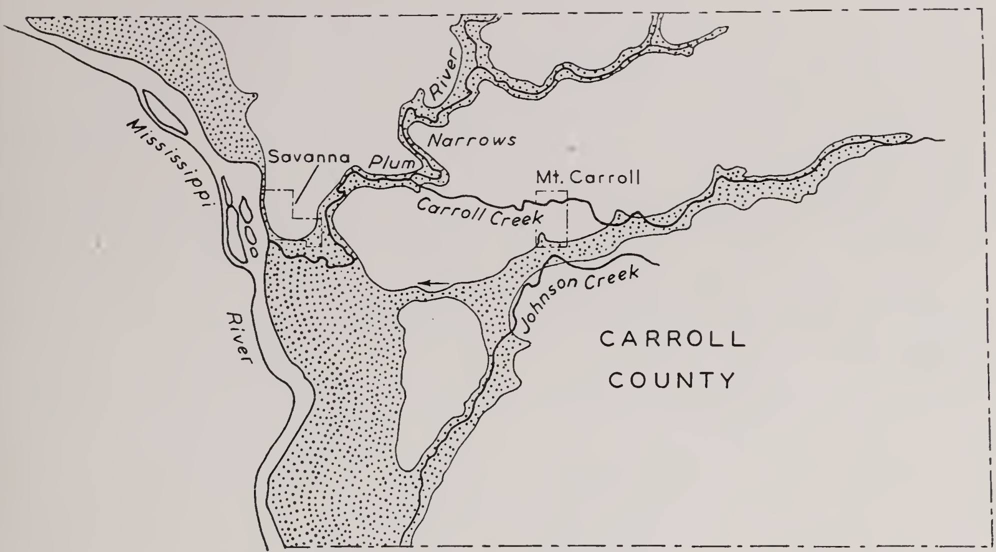

FIG. 10.—Preglacial valleys (stippled) and present streams in the vicinity of Savanna, Carroll County. A possible glacial spillway is shown by the arrow.

3 miles long, was eroded in the Galena dolomite along the spillway so that the former course was abandoned. The canyon is an outstanding scenic feature in northern Illinois and is the site of Apple River Canyon State Park. The buried valley of Yellow River lies east and north of Stockton and is shown by several well records which report abnormal drift thicknesses (pl. 1).

Plum River Valley.—Plum River heads in southeastern Jo Daviess County and flows southwestward to join the Mississippi at Savanna in Carroll County (fig. 10). About 5 miles above Savanna the stream flows through a narrow gorge which Leverett[15] regarded as the possible site of a preglacial divide between Plum River on the east and a smaller stream, now represented by lower Plum River, on the west.[16] It was suggested further that the preglacial valley buried by drift continued southward a few miles to the east of the present lower course. This interpretation is not substantiated by the evidence now available. Numerous bedrock exposures southeast of the present valley indicate the presence of a continuous bedrock ridge and exclude the possible existence of a large buried valley across it. A natural explanation for the narrows is found in the fact that the stream at this point crosses Silurian dolomite in the center of a syncline, whereas both above and below it flows in a broader valley in the Maquoketa shale (fig. 7).

Johnson Creek Bedrock Valley.[17]—Johnson Creek, the first important stream south of Plum River, occupies a preglacial valley in its lower course but the upper portion of the stream is flowing in a recent valley eroded in the glacial drift (fig. 10). The lower preglacial portion of the valley is almost a mile wide and extends northward from its mouth for 6 miles where it ends abruptly against a fill of glacial drift. Beyond this point the buried bedrock valley swings to the east and continues eastward along the present valley of Carroll Creek to its headwaters in eastern Carroll County. These relations substantiate Leverett's conclusion that Carroll Creek formerly discharged southward into Johnson Creek valley from a point just east of Mt. Carroll.[18]

An additional drainage modification is suggested by the channel that transects the Mississippi-Johnson Creek divide southeast of Savanna (fig. 10). This channel is

[15]The Illinois glacial lobe: U. S. Geol. Survey Mon. 38, p. 478, 1899.
[16]The topographic relations are shown on the Savanna quadrangle map.

[17]This feature is shown on the Savanna quadrangle map, and other portions of the valley are shown on the Cordova and Mt. Carroll maps.
[18]Leverett, Frank, op. cit., p. 478.

much narrower and probably not as deep as the bedrock valley along Johnson Creek and so could hardly represent the lower course of preglacial Johnson Creek. As the channel lies close to the Illinoian drift border, it seems probable that it was eroded as a glacial spillway when Illinoian ice filled the valley to the east. This possibility needs to be verified by field studies as the glacial boundary is poorly defined because of the thin and patchy character of the drift and the loess cover.

Glacial Channels

Cattail Channel.—Abandoned Cattail Channel leaves the present Mississippi Valley near Fulton and extends southeastward for a distance of five miles to join Rock Creek near the village of Fenton. The valley is a prominent physiographic feature separating the Garden Plain upland from the main upland to the northeast.[19] It is almost a mile in width and has been eroded to a depth of more than 100 feet in Silurian dolomites. To the southeast the channel probably continues as a buried valley and within a short distance joins Rock Creek bedrock valley (pl. 1). The narrow and steep-walled section of the valley north of its mid-point coincides with prominent dolomite exposures and suggests the position of a preglacial divide between north and south drainage at that point.

The deposits filling the valley are at least 70 feet thick and probably considerably more. In their upper part they are reported to consist of peat with a maximum thickness of 30 feet underlain by fine sand.[20]

A pre-Illinoian age was assigned to the channel by Carman[21] because of the presence of Illinoian drift on its slopes. Accepting this evidence, temporary diversion of the Mississippi through the channel was probably caused by Kansan or Nebraskan ice which advanced from the northwest and blocked the preglacial valley south of Fulton. After partial filling of the valley by Illinoian drift, it may have been reopened as the result of the Iowan glacial invasion from the west which dammed the main valley. The channel was unquestionably open during later Wisconsin substages as its floor at present is only slightly above flood stages of the Mississippi.

Minor channels between Fulton and Cordova.—Within this area there are four rock "islands" that have been isolated from adjoining uplands. Three of these rock hills, at Fulton, Clinton, and Albany, are surrounded by Wisconsin outwash and are prominent physiographic features;[22] the fourth is suggested by a single well record and, if present, exists as a small buried rock knob opposite the mouth of Wapsipinicon River (pl. 1). All of these channels appear to be related to alluviation of the valley by Wisconsin outwash rather than to glacial diversions.

PRINCETON BEDROCK VALLEY

Physiographic Evidence

The presence of the large buried Princeton bedrock valley joining the upper Mississippi Valley below Fulton with the Illinois Valley at the "Big Bend" (fig. 11) would be suspected from physiographic evidence alone.

1) The steep-walled rock gorge along the upper (Rock Island) narrows of the present Mississippi between Cordova and Muscatine, Iowa, is clearly younger than the valley above. (Cordova, Milan, and Edgington quadrangle maps.)

2) Abandoned Meredosia Valley turns east from the main valley just above the rapids and is comparable to the upper valley in size. (Cordova quadrangle.)

3) Meredosia Valley leads into the broad, outwash-filled Green River Lowland which stretches eastward into western Bureau County where it ends abruptly against the Bloomington moraine. (Cordova, Orion, Prophetstown, Geneseo, Annawan, and Buda quadrangle maps.)

4) Rock and Green River valleys south of Meredosia Channel likewise lead east into the Green River Lowland. To the

[19] Shown on the Cordova quadrangle map.

[20] Carman, J. E., The Mississippi Valley between Savanna and Davenport: Illinois Geol. Survey Bull. 13, p. 57, 1909.

[21] Idem, p. 66.

[22] Cordova quadrangle map.

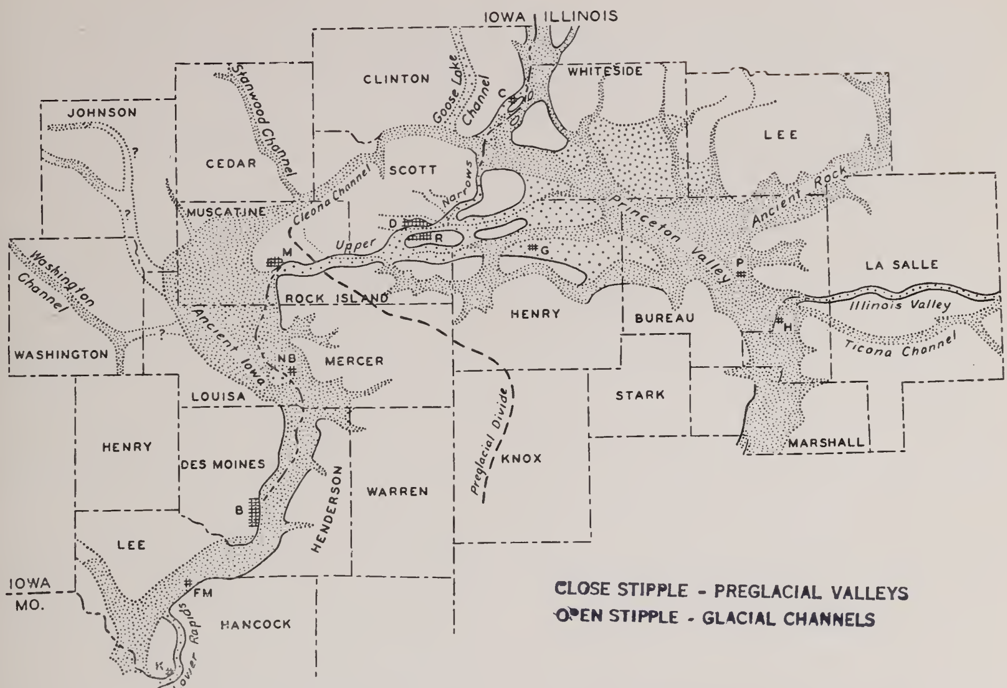

Fig. 11.—Bedrock channels in the Rock Island region, northwestern Illinois and eastern Iowa. B—Burlington; C—Clinton; D—Davenport; FM—Fort Madison; G—Geneseo; H—Hennepin; K—Keokuk; M—Muscatine; NB—New Boston; P—Princeton; R—Rock Island. Channels in Iowa compiled from data by Udden, Norton, Calvin, Leighton, and Schoewe.

west these valleys are probably joined through Pleasant Valley by a drainage system now represented by barbed tributaries of the Mississippi—Blackhawk, Duck, Crow, and Spencer creeks in Scott County, Iowa. (Rock Island, Cordova, and Orion quadrangle maps.)

5) The broad valley of Wapsipinicon Valley in Iowa joins the Mississippi Valley directly west of Meredosia Channel. Its tributaries suggest that drainage was originally eastward rather than westward. There is no physiographic evidence of a large valley extending up the Wapsipinicon and southwestward to join the broad valley of the Mississippi below Muscatine. (Cordova and Rock Island quadrangle maps.)

6) The broad valley of Illinois River below the "Big Bend" is larger in size than the upper Mississippi Valley and provides a logical course for the preglacial Mississippi as well as for preglacial Rock River. (Hennepin, LaSalle, and Lacon quadrangle maps.)

It may be concluded that the preglacial Mississippi Valley lies buried either to the west in Iowa or to the east in Illinois, and that only the eastward course is supported by purely physiographic evidence.

Subsurface Evidence

Bedrock elevations along the present valleys of Mississippi and Rock rivers between Meredosia Channel and Muscatine are all 500 feet or more above sea-level with the great majority of elevations about 555 feet above sea-level. The average elevation of the bedrock floors of these valleys would thus be roughly 250 feet above the ancient Mississippi channel to the north so that only elevations below 500 feet would be significant in locating the preglacial channel.

In the Green River Lowland most wells obtain water from surficial outwash and there are few records which provide bedrock elevations. The elevations obtainable, however, indicate that the bedrock is uniformly low. In southern Whiteside County bedrock is 418 feet above sea-level at

Erie, 434 feet at Prophetstown, and 425 feet in sec. 31, T. 19 N., R. 4 E., and near the western boundary of Bureau County it is 402 feet above sea-level. East of the Green River Lowland thick till of the Bloomington moraine replaces the outwash, and there are numerous records that give evidence of low bedrock elevations across central Bureau County and into the present Illinois Valley. These elevations, however, are not as significant as those farther west because they could be interpreted as lying along the buried valley of ancient Rock River.

The nature of the bedrock surface adjoining the preglacial valley is just as significant as the low elevations within the channel itself. The profound topographic discontinuity between the Silurian Upland on the north and the Pennsylvanian Upland on the south is apparent on the bedrock-surface map (pl. 1) and is emphasized by recognition of Green River bedrock lowland. The eastward trend of tributary valleys in Whiteside, Rock Island, and Henry counties suggests both the location of the valley and its eastward slope.

There is also subsurface evidence of low bedrock elevations along the possible preglacial course in eastern Iowa. These elevations have been interpreted as indicating a buried channel which extended up the Wapsipinicon Valley to a point just below the northward bend of that river, thence southwestward as "Cleona Channel" through Durant and into a buried valley along Cedar and Iowa rivers, finally entering the preglacial valley of the Mississippi below Muscatine (fig. 11).[23] The elevation of bedrock along Cleona Channel is about 400 feet above sea-level, and south of Muscatine it is less than 390 feet above sea-level. Although these elevations are comparable to those along Princeton Valley, the width of the eastern part of the channel is much less. This led Leverett[24] to conclude that the main preglacial valley probably extended southeast from Fulton to the Illinois Valley. The nature of the buried valley in Illinois revealed by the present study supports this conclusion.

Description

As interpreted on the bedrock-surface map, the preglacial Mississippi Valley follows the Meredosia Channel from the Mississippi Valley to present Rock River Valley just north of Erie. From this point the channel continues southeastward as a buried channel across the northeast corner of Henry County and diagonally through Bureau County to join the present Illinois Valley south of Hennepin in western Putnam County. The bedrock contours in the Green River Lowland are highly generalized because of lack of data.[25]

The available evidence indicates that the average width of the deepest part of the valley is about five miles and that it lies 250 to 350 feet below the surrounding bedrock uplands. The estimated gradient based on bedrock elevations near Fulton and at Hennepin (table 2) is 1.6 feet per mile. The valley walls are not sharply defined except at the lower and upper ends of the valley. This is due in part to incomplete data, but in addition there are strong suggestions that the preglacial valley was modified extensively by shiftings of drainage during Pleistocene time. A rock terrace 550 to 600 feet above sea-level or 150 to 200 feet above the main channel appears to be present in northern Henry and southern Whiteside counties and may represent the same Pleistocene baselevel as the bedrock floor of Rock River Valley in the Rock Island region. The present southern margin of the Green River Lowland, especially between Geneseo and Atkinson in Henry County,[26] is so abrupt and linear that it appears to be a valley-wall eroded in the Illinoian drift-plain by a major stream.

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[23]Leverett, Frank, op. cit., U. S. Geol. Survey Mon. 38, pp. 462-67.
Norton, W. H., The geology of Scott County: Iowa Geol. Survey, vol. 9, pp. 413-15, 492-93, 1899.
Udden, J. A., Geology of Muscatine County: Iowa Geol. Survey, vol. 9, pl. 7, pp. 322, 326-27, 1899.

[24]Leverett, Frank, op. cit., U. S. Geol. Survey Mon. 38, p. 467. Shiftings of the Mississippi River in relation to glaciation; Bull. Geol. Soc. America, vol. 53, p. 1292, 1942.

[25]The course east of Meredosia Valley is essentially the same as that proposed by J. C. Frye on the basis of well records and electrical earth-resistivity measurements in: "Additional studies on the history of Mississippi Valley drainage," unpublished doctor's thesis, State Univ. of Iowa, p. 36 and pl. 1, 1938. It differs from Frye's interpretation in that Meredosia Channel rather than Cattail Channel is considered to be the course of the ancient Mississippi.

[26]Shown on the Geneseo and Annawan quadrangle maps.

J. R. Lewis—Miller Estate Well No. 1, SW. corner NE. 1/4, sec. 24, T. 15 N., R. 9 E., Bureau County
Elevation 660 feet A.T.

	Thickness Ft.	*Depth Ft.*
Pleistocene System		
Wisconsin drift		
Till, calcareous, buff to gray	12	12
Gravel, sandy	19	31
Sand, gravelly, clean	39	70
Illinoian (?) drift		
Till, calcareous, brown with pink tint	24	94
Sand, clean	7	101
Till, calcareous, brown with pink tint, wood fragments	39	140
Till, calcareous, silty, gray	12	152
Sand, clean	6	158
Pre-Illinoian deposit		
Silt, reddish-brown	18	176
Sand and gravel, clean, largely quartz; numerous rounded polished pink grains	24	200
Sand, as above, silty	25	225
Sand, as above, and gravel, clean	40	265
Pennsylvanian System		
Shale, carbonaceous, black	5	270

This feature, together with the general absence of Illinoian till within Green River bedrock lowland, indicates that the Mississippi flowed through the lowland during the Sangamon interglacial interval and could have eroded the rock terrace. The alternative that the terrace is preglacial and thus older than the deep part of the channel cannot be eliminated, but it is discounted by the evidence of important erosion during the Sangamon interval.

The surficial deposits forming the upper part of the glacial fill in Princeton Valley consist primarily of Bloomington outwash in the Green River lowland and of thick Bloomington till forming morainic ridges to the east. Associated with the Bloomington outwash in the western part of the lowland are isolated remnants of Shelbyville till together with a complex of contemporaneous outwash, older terrace sands and silts, Peorian loess, and recent sand dunes. The older drift below the Wisconsin is more than 100 feet thick in places and appears to consist dominantly of sand and gravel. The stratigraphic relations of the older deposits are complex and at present correlations are uncertain. It is clear that Illinoian till and thick deposits of pre-Illinoian sand and gravel are present at many places. The record of the Lewis-Miller Estate well, based on the study of sample cuttings, appears to be representative of the deposits in the eastern part of the valley.

One of the few records based on sample well cuttings from the western part of the valley is that of the Harrington-Doty well.

The distinctive red polished pre-Illinoian sand in these sections consists of 70 percent or more quartz grains and is so different from most glacial sands that it is believed to be primarily nonglacial in derivation. This sand, which occurs elsewhere

Harrington Brothers—S. L. Doty Well, SE. corner NW. 1/4, sec. 8, T. 17 N., R. 6 E., Bureau County
Elevation 620 feet A.T.

	Thickness Ft.	*Depth Ft.*
Pleistocene System		
Wisconsin outwash		
Sand, largely angular quartz, clean	48	48
Pre-Illinoian deposit		
Sand and gravel, numerous rounded and polished grains, clean	18	66
Silt, calcareous, humus, wood fragments, gray	4	70
Sand, as above	2	72
Silt, as above	14	86
Sand, some gravel, polished, buff, red and black	132	218
Silurian System		
Dolomite		

at numerous points along the ancient Mississippi Valley (fig. 22) as the lowermost deposit in the valley-fill, will hereafter be termed the "Sankoty sand" because of its development at the Sankoty water field just north of Peoria in which general area it is known to underlie Kansan drift. Although it is recognized that sand of this type could have been deposited at different times under similar environmental conditions, and correlation is uncertain, the deposit is significant in indicating the continuity of Princeton and middle Illinois bedrock valleys.

In its relation to structure the valley crosses a north-south anticline in western Whiteside County and continues southeast along the axis of the major syncline adjoining the LaSalle anticline on the southwest (fig. 19). The narrow upper portion of the valley is eroded in Silurian dolomites and Devonian limestones, whereas the wide valley below lies within the weaker Pennsylvanian beds preserved in the syncline and seems definitely related to structure (fig. 7).

Meredosia Channel

The abandoned bedrock valley[27] in northern Rock Island and southwestern Whiteside counties is a prominent feature of the present landscape and merits special description (pls. 1 and 2). Like its smaller counterpart to the north, Cattail Channel, the Meredosia Channel crosses the Silurian Upland and isolates the Coe upland south of the valley from the rest of the upland. The valley is about four miles wide and its bedrock floor probably lies more than 300 feet below the upland to the south of it. Prominent dolomite cliffs occur along the steep south wall of the valley whereas the north slope of the valley is drift-covered and has a gentle slope. The valley-fill is reported to consist of sand to a depth of at least 100 feet.[28]

Except for temporary diversions the valley appears to have been occupied by the Mississippi from preglacial time until the Wisconsin glacial stage when the present course across the upper rapids in northern Rock Island County was established. The channel is filled with late Wisconsin outwash, indicating that the valley continued in use until recent time. Its lowest point is still below flood stages of the Mississippi.

Tributaries

The main tributaries of Princeton Valley are largely buried by drift and are not expressed in the present topography except locally where restricted portions have been exhumed or re-occupied by present streams. On the north these valleys head near the crest of the Galena Upland in eastern Carroll and western Ogle counties and slope southward to the main valley. The four important valleys in this group are, from west to east: Rock Creek bedrock valley, Elkhorn Creek bedrock valley, Pine Creek bedrock valley, and finally Pawpaw Valley (ancient Rock River bedrock valley) which is described in another section (pls. 1 and 2).

South of the main Princeton Valley the larger tributaries head along the preglacial divide which crosses the present Mississippi near Fairport, Iowa, and have a general eastward, rather than a northward, trend. These valleys include the Duck Creek bedrock valley system, Green River bedrock valley, Mud Creek bedrock valley in eastern Henry County, and buried Buda Valley in southwestern Bureau County. The bedrock valley systems in this region are complex and involve uncertainties which are discussed below.

Rock Creek Bedrock Valley.—Rock Creek now heads in eastern Carroll County and flows southward in a preglacial valley into northern Whiteside County where the old valley is buried by drift and the present stream continues in a recent valley. The postglacial valley is characterized by narrow rock gorges where the stream is superposed on upland spurs and by broad reaches where it coincides with the drift-filled preglacial valley.[29] In the vicinity of Morrison the buried valley lies about two miles east of the present stream. Below Morrison the valley continues south, apparently through Prophetstown where

[27]Shown on the Cordova quadrangle map.

[28]Carman, op. cit., p. 56.

[29]Shown on the Morrison quadrangle map.

bedrock is unusually low, to enter Princeton Valley. The location of this valley, now established by well records, is essentially the same as that proposed by Leverett[30] on the basis of physiographic relations. The initial diversion of the stream appears to be due to the Illinoian ice advance from the northeast which partly buried the valley above Morrison. Later during the Wisconsin stage the valley south of Morrison was completely buried by Shelbyville till and Bloomington outwash which underlie the present Green River lowland.

In going from north to south the valley crosses Galena dolomite, Maquoketa shale, and Silurian dolomites respectively. The relatively wide valley in southern Carroll County coincides with the Maquoketa shale.

Elkhorn Creek Bedrock Valley.—The Elkhorn Creek bedrock valley is similar to the Rock Creek bedrock valley in its regional relations (pls. 1 and 2). Above Rock River the modified preglacial valley is occupied by the present stream; below Rock River the valley is buried by drift in the Green River Lowland and, although its exact location is uncertain, it probably continues almost directly southward to join Princeton Valley as previously indicated by Leverett.[30] In the southeastern corner of Carroll County the valley follows the strike of the Maquoketa shale for a distance of about five miles and widens perceptibly. The glacial history of the valley is similar to that of Rock Creek.

Pine Creek Bedrock Valley.—Like the two preceding streams the present Pine Creek follows a preglacial valley south to Rock River, beyond which the preglacial valley is buried by Illinoian and Wisconsin drift (pls. 1 and 2). Below the mouth of the present stream the ancient valley probably turned east along the present Rock River valley to Grand Detour where, joined by a tributary from the north, it turned southward along the present drainage basin of Chamberlain Creek to the vicinity of Nachusa (sec. 6, T. 21 N., R. 10 E.); from Nachusa the valley led west along Threemile Creek to the western part of Lee County where it turned south to join ancient Rock River Valley just above its mouth.[31]

Duck Creek Bedrock Valley System.—It is believed, as originally suggested by J. A. Udden,[32] that the barbed tributary valleys north of the present Mississippi River near Rock Island formerly discharged eastward through Pleasant Valley and finally entered Princeton Valley by way of a preglacial valley along present Rock River. In addition to Duck Creek Valley, the system probably included the valleys of Crow and Spencer creeks to the north and the valley of Blackhawk Creek on the south, the latter continuing eastward along the present valley of the Mississippi to its junction with Duck Creek (fig. 11). This interpretation is adopted because it provides the most natural and direct route to Princeton Valley. The alternative of drainage eastward by way of a preglacial valley along present Green River, though less direct, cannot be eliminated by the evidence now available.

Diversion of the drainage system into the present Mississippi probably occurred with the advance of early Wisconsin ice into the Green River lowland. Pleasant Valley, which is underlain by late Wisconsin outwash, was kept open until recent time.

Green River Bedrock Valley.—The present course of Green River across northern Henry County appears to follow the course of a buried valley which extended from the preglacial divide at Fairport, Iowa, eastward to Princeton Valley[33] (fig. 11). The uppermost part of this valley may be represented by the present valley of Pine Creek

[30]Leverett, Frank, op. cit., U. S. Geol. Survey Mon. 38, pl. XII, op. p. 130.

[31]This course is somewhat similar to the preglacial course proposed by Leverett (Mon. 38, pl. XIII), but differs greatly from R. S. Knappen's interpretation, Geology and mineral resources of the Dixon quadrangle: Illinois Geol. Survey Bull. 49, pl. IV, pp. 98-101, 1926.

Leverett's interpretation of the valley above Nachusa is similar to the writer's, but beyond this point Leverett extended the valley directly southeastward to the northwest corner of LaSalle County instead of to the southwest. The southeast course is discounted by more recent data which show that the valley would cross an area in which bedrock is uniformly high and in which there are numerous bedrock exposures. Knappen believed that the ancient valley turned west from the present mouth of Pine Creek along present Rock River Valley to the Whiteside County boundary where it turned south to the ancient Mississippi. This interpretation was not adopted because of the lower elevations and wider valley along the course to the south. It is recognized, however, that a positive conclusion is unwarranted and that additional well records are needed to decide the issue.

[32]Unpublished study reported by Leverett, U. S. Geol. Survey Mon. 38, p. 465.

[33]Edgington quadrangle map.

which heads along the preglacial divide in Iowa and enters the Mississippi just east of Fairport. Beyond this point the preglacial valley is interpreted as continuing eastward along the present Mississippi almost to the mouth of Rock River, thence south into the large buried valley south of Rock River which is followed into the main channel along Green River. This course is proposed because bedrock elevations along the buried valley are lower than they are along the more direct course up the present valley of the Rock River. As a correlative it is believed that the valley of Rock River south of the Rock Island upland is a younger Pleistocene valley, possibly eroded along a minor west tributary of the major preglacial valley.

The difficulties in unraveling the complex drainage history of this area have long been appreciated, and the recognition of low bedrock south of present Rock River adds another confusing element to the problem. At present no single interpretation can be urged too strongly, and the interpretation suggested above should be regarded purely as a working hypothesis.

The available evidence indicates that the buried section of the valley was so filled by Kansan and possibly older drift that by Illinoian time it had ceased to exist as an active drainage line. Thick pre-Illinoian drift was encountered in wells along the valley, and the reconstructed surface of the Illinoian till-plain for the most part slopes across the old valley toward present Rock River without interruption. The upper part of the buried valley is reflected on the reconstructed till-plain as a sag which is followed by Mill Creek in its upper course.[34] The lower part of the valley along Green River was reopened and modified by erosion during the Sangamon interval and later buried again by Shelbyville till and Bloomington outwash during Wisconsin time.

Mud Creek Bedrock Valley.—The Mud Creek bedrock valley is interpreted as a modified preglacial valley which extended eastward across central Henry County to join Princeton Valley at some point east of the village of Annawan (fig. 11 and pls. 1 and 2). Bedrock-surface data in the area are scattered and alternative interpretations are possible. Parts of the valley are completely filled with Illinoian and probably older drift, while other sections, as along Mud Creek southwest of Annawan and Geneseo Creek southwest of Geneseo, are reflected in the present topography. Abnormally low elevations near the postulated head of the valley indicate that it may be connected with upper Green River bedrock valley by a spillway or that actually the preglacial drainage of upper Green River bedrock valley continued east through the Mud Creek valley rather than to the north. The latter interpretation provides a more natural course but is opposed by the narrowness of the valley southwest of Geneseo and by the discontinuity in bedrock exposures along the north course, suggesting the presence of a buried valley. The valley appears to have been buried at the same time as upper Green River Valley.

Buda Bedrock Valley.—The position of the Buda bedrock valley is not clearly outlined because of lack of data. It appears that the valley drained most of the Pennsylvanian upland in southwestern Bureau County and entered Princeton Valley in the vicinity of Buda where the elevation of bedrock is unusually low. The West Fork of upper Spoon River probably drained northeastward through this valley in preglacial time and was diverted southward into the present course by the Illinoian glacier.

GLACIAL CHANNELS IN THE ROCK ISLAND REGION[35]

The preglacial drainage of this area (fig. 11) has been discussed on preceding pages so only the present river courses and possible glacial drainage are outlined at this point.

Upper Narrows of Mississippi River

The narrows between Cordova and Muscatine vary in width from half a mile to

[34]Shown on the Milan quadrangle map.

[35]Shown on the Cordova, Rock Island, Milan, and Edgington quadrangle maps.

about two miles and have been entrenched 75 to 200 feet below adjoining rock uplands, the deepest erosion being at the preglacial divide in western Rock Island County. Included within the narrows are the upper or Rock Island rapids which, strictly speaking, occupy a 14-mile stretch of the river between Port Byron and LeClaire. The rapids consist of a series of "chains" and pools eroded in Niagaran dolomite and Devonian limestones. Formerly the fall was about 20 feet, and during low water the depth of the channel fell as low as 30 inches.

In summary of the possible relations of the valley (fig. 11) to preglacial topography, it may be stated that the valley from northeast to southwest extends: (1) Up a small preglacial tributary of the ancient Mississippi; (2) across a low divide near LeClaire; (3) down the preglacial valley of Spencer Creek; (4) up the preglacial valley of Blackhawk Creek past Davenport; (5) across a divide to the southwest; (6) up the preglacial valley of Pine Creek (head of Green River bedrock valley); (7) across a divide into the ancient Iowa (Middle Mississippi) Valley.

Bedrock Valley of Lower Rock River[36]

Following the interpretations of preglacial topography previously stated, the present Rock River below its narrows at Sterling extends from northeast to southwest: (1) Across the Green River Lowland; (2) up the valley of preglacial Duck Creek; (3) across a divide at Carbon Cliff; (4) up a western tributary of Green River bedrock valley; (5) across a divide just above its mouth near Milan.

Possible Glacial Drainage

Glacial shiftings of drainage in the area (based largely on studies by Frank Leverett[37]) are summarized below. During the Nebraskan glaciation the ancient Iowa Valley (fig. 11) was probably blocked near the lower rapids above Keokuk, and melt water discharged eastward into the ancient Mississippi. Whether this eastward course was maintained during the following interglacial stage is uncertain. The Kansan ice, however, undoubtedly diverted drainage eastward, and this course probably continued until the Illinoian invasion from the Labradorean center. The Yarmouth drainage system appears to have included all of the ancient Iowa (Middle Mississippi) system above the lower rapids and, although the course in the Rock Island region is not indicated by Leverett, the most direct drainageway would be eastward along Mississippi, Rock, and Green River valleys into Princeton Valley. With the advance of the Illinoian ice the ancient Mississippi took a temporary course through Iowa along the margin of the ice, but may have returned to the preglacial course upon withdrawal of the ice and maintained it throughout the Sangamon interglacial interval.[38] During the Wisconsin glaciation the Mississippi became permanently established in its present course through the upper narrows. As suggested by M. M. Leighton and George E. Ekblaw,[39] this diversion was caused either by advance of early Wisconsin ice to the eastern edge of the Coe upland in northern Rock Island County, thus blocking Princeton and present Rock River valleys and forcing drainage through a low col near Port Byron at the head of the upper narrows, or by the filling of both Mississippi and Rock River valleys by glacial outwash to a level which permitted overflow through the col and adoption of a more direct course.

MIDDLE ILLINOIS BEDROCK VALLEY

Description

The middle section of the ancient Mississippi Valley follows the same general course as the present Illinois River Valley between the big bend near Hennepin south to Peoria, a distance of about 35 miles.

[36]Shown on the Cordova, Orion, Milan, and Edgington quadrangle maps.

[37]Shiftings of the Mississippi River in relation to glaciation: Bull. Geol. Soc. America, vol. 53, pp. 1293, 1297, 1942.

[38]Also suggested by Trowbridge, A. C., Williams, A. J., Frye, J. C., and Swenson, F. A., *in* Pleistocene history of the Mississippi River (abs.): Proc. Iowa Acad. Sci., vol. 48, p. 296, 1941.

[39]Kansas Geological Society, Guidebook Ninth Annual Field Conference, p. 44, Wichita, Kansas, 1935.

W. H. Packard—John A. Fitschen Well, SE. 1/4, sec. 20, T. 29 N., R. 2 W., Marshall County
Elevation 525 feet A.T.

	Thickness Ft.	Depth Ft
Pleistocene System		
Illinoian drift		
Till, calcareous, reddish-brown	60	60
Pre-Illinoian deposit—Sankoty sand		
Sand, medium to fine, very silty, leached, oxidized, reddish-brown	10	70
Sand, medium to fine, slightly silty, oxidized, largely quartz, buff	20	90
Sand, medium to coarse, slightly silty, oxidized, calcareous, buff	15	105
Sand, medium to coarse, and gravel, many rounded and polished grains	5	110

The west bluff of the present valley closely corresponds with the margin of the bedrock valley, but the east bluff is eroded entirely in glacial drift and lies two to six miles west of the eastern margin of the larger bedrock valley (pl. 1). The presence of bedrock exposures along the west edge of the valley and their absence on the east is a reflection of this situation. The average width of the preglacial valley is about seven miles as compared with about four miles for the present valley. If the unusually low bedrock elevation of 273 feet above sea-level at Hennepin is accepted, the deepest part of the valley lies below the 300-foot contour or 300 to 350 feet below adjoining uplands. The steep west wall of the valley and the rock bench west of the main channel in Marshall County indicate a westward shifting of drainage as the result of glaciation, probably during the Wisconsin stage.

The sediments filling the valley are composed of Wisconsin, Illinoian, and pre-Illinoian deposits, the latter including thick sections of Sankoty sand and gravel. Along the present valley these deposits have a maximum thickness of about 200 feet and are composed almost entirely of sand and gravel with 50 to 60 feet of alluvium and Wisconsin outwash resting on older deposits. Outside the present valley the fill consists of thick Wisconsin till overlying Illinoian till and Sankoty sand.

The sample-study record of the Packard-Fitschen well in the buried section of the valley in southern Marshall County indicates the general character of the lower deposits.

Other wells in which Sankoty sand has been penetrated are shown in figure 23, page 106.

Tributary Valleys and Glacial Channels

The tributaries join the main valley almost at right angles and include four valleys of significant size: (1) Ticona Valley and (2) the present Upper Illinois Valley which enter the upper part of the valley from the east, and (3) Wyoming and (4) Kickapoo Creek bedrock valleys which enter the main valley from the west (pls. 1 and 2).

Ticona Bedrock Valley.—The Ticona Valley, first described by Willman,[40] was named for the railroad station of Ticona in western LaSalle County. Willman considered the valley system to be preglacial and extended it eastward to include the preglacial drainage of most of LaSalle, Kendall, Will, Grundy, and Livingston counties. He considered diversion by Nebraskan ice as the most likely explanation for the course of the deep Ticona channel across the LaSalle anticline. In the present study this drainage system is regarded not as a preglacial system, but as a Pleistocene system which originated during the Kansan or possibly Nebraskan ice advance from the northeast and continued until the retreat of the Cropsey glacier[41] during the Tazewell substage of the Wisconsin. The preglacial drainage of the area east of Vermilion River is believed by the writer to have been southward through Kempton Valley (pl. 2) into River Mahom-

[40]Willman, H. B., Pre-glacial River Ticona: Illinois Acad. Sci. Trans. vol. 33, pp. 172-175, 1940; Illinois Geol. Survey Cir. 68, pp. 9-12, 1940.
Willman, H. B. and Payne, J. N., Geology and mineral resources of the Marseilles, Ottawa, and Streator quadrangles: Illinois Geol. Survey Bull. 66, pp. 149-151, fig. 88, pls. 4, 5, and 6, 1942.
[41]Willman and Payne, op. cit., p. 215, 1942.

et with only the downstream part of Ticona Valley draining westward as a relatively small tributary of the ancient Mississippi.

This interpretation is proposed for the following reasons: (1) As pointed out by Willman,[42] the regional slope of the bedrock surface is east rather than west; (2) the eastern part of the drainage basin continues southward into Kempton Valley; (3) the east-flowing tributary north of Illinois River in central LaSalle County (fig. 10), which was in the anomalous position of having to bend back on itself to enter a preglacial Ticona Valley, now becomes a normal tributary of the major Newark-Kempton Valley; (4) the section of Ticona bedrock valley south of Illinois River crosses a regional upland which continues for many miles to the north and south, and the width of the valley, which is less than two miles, is neither in harmony with other preglacial valleys of comparable length or with its own headwaters (pl. 1); (5) the occurrence of Kansan drift within a tributary valley of River Ticona near Wedron in central LaSalle County (sec. 9, T. 34 N., R. 4 E.) described by Willman[43] evidences the pre-Kansan age of the local valley but does not invalidate the Kansan or Nebraskan age of the main channel south of Illinois River.

The Ticona Channel connecting the Kempton-Newark drainage with the ancient Mississippi is a narrow steep-walled valley at least 300 feet deep (pls. 1 and 2). The elevation of bedrock near the mouth of the valley is about 300 feet above sea-level which is 150 feet below the level of Illinois River. Along the crest of the LaSalle anticline the channel cuts through the Pennsylvanian rocks to form a window of St. Peter sandstone and Galena dolomite; elsewhere, the channel is eroded in Pennsylvanian strata. The valley is now completely buried by drift which consists of Wisconsin till underlain by undifferentiated older deposits composed largely of sand and gravel which reach thicknesses of more than 100 feet.

Upper Illinois Bedrock Valley.—The recent bedrock valley occupied by Illinois River above the big bend in Bureau and LaSalle counties is well known from previous publications[44] and is not described here. As a matter of comparison it may be noted that the valley is even narrower than the Ticona Channel and has a maximum depth in bedrock of 175 feet, or 125 less than Ticona Valley (pl. 1).

Wyoming Bedrock Valley and Upper Spoon River Drainage Basin.—The presence of a buried bedrock valley, here termed Wyoming Valley, joining the upper Spoon River drainage basin with the Middle Illinois Valley to the east is indicated by low bedrock elevations in southwestern Marshall and in southern Stark counties. It is believed that Spoon River above the narrows west of Williamsfield in eastern Knox County and its western tributaries, Court Creek and Walnut Creek, formerly drained eastward through Wyoming Valley and finally entered the ancient Mississippi in the northeastern corner of Peoria County (pls. 1 and 2). This interpretation is based primarily on the narrows and anomalous course of Spoon River and on the buried eastward continuation of Walnut Creek valley.

The valley system is at least pre-Illinoian in age, because the main tributaries are reflected in the Illinoian drift-plain as sags and are occupied by present streams. Diversion to southward drainage through the narrows happened before the Wisconsin ice invasion, as Wisconsin valley-train deposits occur as terraces within the narrow section of the valley. As there is no direct evidence of Kansan or Nebraskan ice invading the area from the east, diversion was probably brought about by early Illinoian ice.

[42] Pre-glacial River Ticona, op. cit., p. 172.
[43] Willman and Payne, op. cit., pp. 151-52, 1942.

[44] Sauer, C. O., Geography of the Upper Illinois Valley and history of development: Illinois Geol. Survey Bull. 27, 1916.

Sauer, C. O., Cady, G. H., and Cowles, H. C., Starved Rock State Park and its environs: Geographic Society of Chicago Bull. 6, 1918.

Cady, G. H., Geology and mineral resources of the Hennepin and LaSalle quadrangles: Illinois Geol. Survey Bull. 37, 1919.

Willman, H. B., and Payne, J. N., Geology and mineral resources of the Marseilles, Ottawa, and Streator quadrangles: Illinois Geol. Survey Bull. 66, 1942.

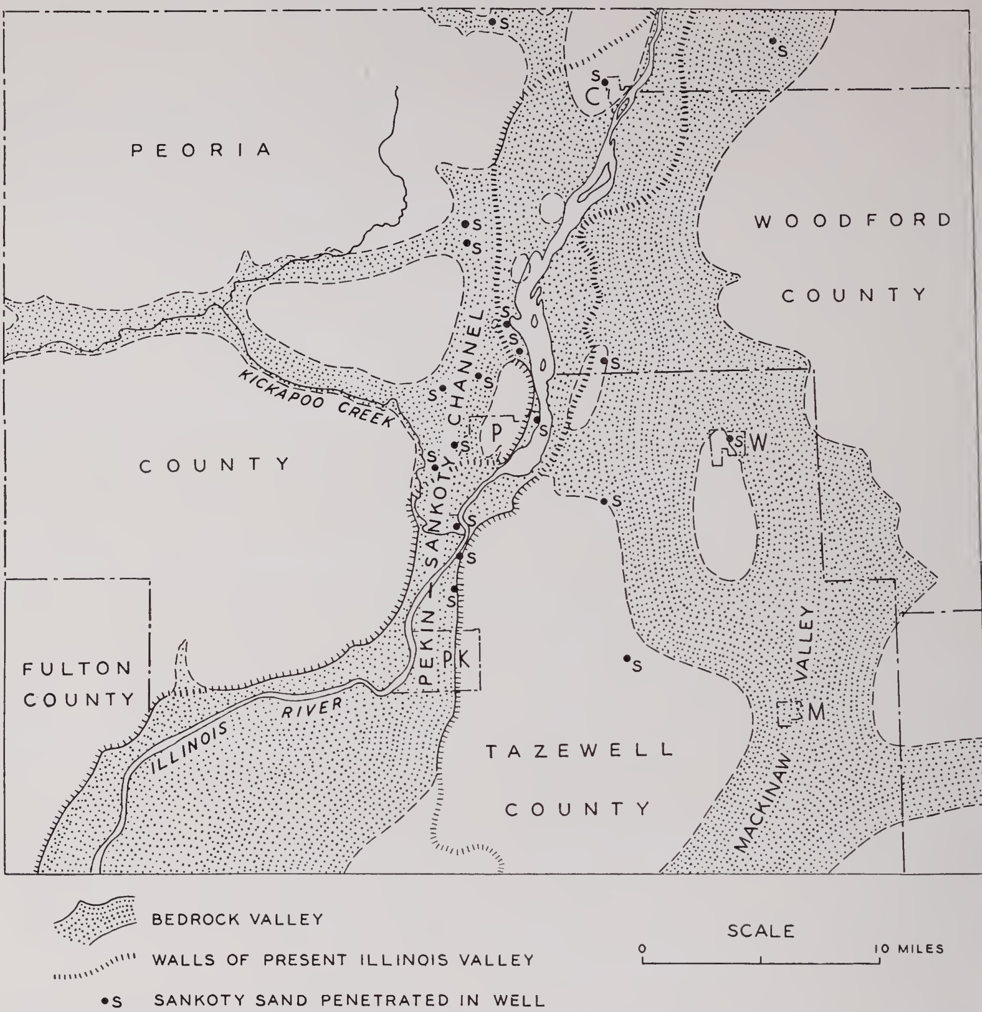

FIG. 12.—Bedrock channels in the Peoria region. C—Chillicothe; M—Mackinaw; P—Peoria; PK—Pekin; W—Washington.

MACKINAW AND ASSOCIATED BEDROCK VALLEYS

Main Valley

Just above Peoria in western Woodford County the ancient Mississippi channel leaves the Illinois Valley and continues southward under the upland as buried Mackinaw Valley to join Mahomet Valley in southern Tazewell County. The narrow bedrock valley of the present Illinois River between Peoria Heights and Pekin makes this clear and led Leverett[45] in 1899 to suggest the possible existence of a buried valley to the east long before the location of Mackinaw Valley was established from subsurface data. Later Udden[46] constructed a generalized bedrock map of the Peoria quadrangle and concluded that either a northwest-southeast preglacial divide crossed the present valley between Peoria and Pekin two miles south of Bartonville or that the narrows in this area were due to the resistant sandstone above coal No. 5. The Peoria quadrangle did not extend far enough east to include Mackinaw Valley or the valley would probably have been dis-

[45]Leverett, Frank, The Illinois glacial lobe: U. S. Geol. Survey Mon. 38, p. 500, 1899.

[46]Udden, Johan A., Geology and mineral resources of the Peoria quadrangle: U. S. Geol. Survey Bull. 506, pl. V, p. 52, 1912.

covered at that time. The present interpretation of the bedrock topography in the region indicates a complex series of drainage changes involving the ancient Mississippi River, Illinois River, and Kickapoo Creek. Valleys representing three different stages of development are shown by the bedrock channels of the region (fig. 12): (1) Mackinaw Valley, which like Middle Illinois bedrock valley, reaches a width of five to ten miles; (2) the bedrock valley of the present Illinois Valley above Pekin and its continuation under the upland northwest of Peoria to Sankoty, which forms a continuous valley about two miles wide; and (3) the bedrock valley of the present river between Peoria and East Peoria which is less than half a mile wide and somewhat shallower than the other two channels.

The position of buried Mackinaw Valley is indicated by records of numerous wells which penetrate abnormal thicknesses of glacial drift and show that bedrock elevations along the old channel are less than 500 feet above sea-level as compared with elevations of 550 to 650 feet on adjoining uplands. The actual bedrock elevation of the valley floor is indicated by a few scattered wells indicating elevations of less than 400 feet and by wells near Mackinaw and Delavan (table 2, p. 46) which are reported to have encountered bedrock at elevations of 295 and 288 feet respectively. The 300-foot contour is carried through the valley on the basis of the 273-foot elevation reported in the valley above at Hennepin (table 2). The presence of two channels in the north part of the valley is suggested by bedrock elevations of 430 to 490 feet in the vicinity of Washington (fig. 12). With additional data this interpretation may be changed, although bedrock elevations of less than 400 feet are shown by well records on all but the north side of the island. Elevations along the south part of the channel are uniformly low, and few wells reach bedrock so that its exact position is somewhat uncertain. The deepest part of the channel is eroded to a depth of more than 350 feet below surrounding uplands and is overlain in most places by 350 to 400 feet of glacial drift.

A detailed section of the glacial deposits at Washington in northern Tazewell County, based on well sample studies, is given in the record of the Ebert-Washington City Well No. 3.

The Sangamon soil zone is persistent throughout the area and constitutes an important datum. The buried soil slopes westward from elevations of about 650 feet in eastern Tazewell County to elevations of 575 to 600 feet near the Illinois Valley. The fact that the old Sangamon plain crosses Mackinaw Valley without interruption and at elevations well above its rim shows that the valley was completely buried by the close of the Illinoian glacial stage. The possibility that it was largely filled at a much earlier date is indicated by the occurrence of Kansan drift up to an elevation of 575 feet and Sankoty sand up to an elevation of 560 feet above sea-level within the valley.

Danvers Bedrock Valley

Danvers Valley is named from the village of that name in western McLean County (sec. 23, T. 24 N., R. 1 W.) where the village well ended in the drift at a depth of 428 feet, indicating that the bedrock surface is less than 392 above sea-level. Because of lack of control the lower deeply buried portion of the valley is shown by generalized contours. The two upper branches are more definitely located. As far as determinable, the valley ranges in width from three to as much as ten miles and lies about 150 feet below adjoining bedrock uplands. Wisconsin, Illinoian, Kansan, and Nebraskan (?) drift and Sankoty sand have been recognized in sample cuttings from wells in the area.

Bedrock Channels in the Peoria Region

Pekin-Sankoty Bedrock Channel.—The Pekin-Sankoty Valley is represented by the bedrock valley along the present river north of Pekin to the mouth of Kickapoo Creek and by a buried continuation which passes under the upland northwest of Peoria to

Chris Ebert—Washington City Well, No. 3, NW. ¼, sec. 24, T. 26 N., R. 3 W., Tazewell County
Elevation 760 feet above sea-level

	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Pleistocene System				
Wisconsin drift				
Tazewell loess				
Soil, dark brown	3		3	
Silt, calcareous, oxidized, yellow	12		15	
Tazewell drift				
Till, calcareous, maroon to gray	68		83	
Gravel, granular to ½ inch, varied lithology	10	7	93	7
Illinoian drift				
Till, calcareous, gray to brown	69	5	163	
Gravel, up to ¾ inch, varied lithology	10		173	
Yarmouth (?) deposit				
Silt, sandy, calcareous, greenish-gray	7		180	
Silt, sandy, calcareous, brownish-gray	5		185	
Kansan drift				
Till, calcareous, brownish-gray	15		200	
Gravel, granular, up to ½ inch	17	6	217	6
Till, calcareous, brownish-gray	32	6	250	
Pre-Kansan deposit, Sankoty sand				
Sand, coarse, gravelly, numerous rounded and polished grains, many pink grains, many oxidized grains, about 75 percent quartz	15		265	
Gravel, up to ⅜ inch, largely oxidized quartzite, some crystalline rocks, highly polished, with sand as above	15		280	
Sand, as above, very coarse to medium, gravelly	20		300	
Sand, as above, medium to coarse, numerous pink grains	10		310	
Gravel and coarse sand, as above	10		320	
No sample	5		325	
Sand, as above, medium to very coarse, gravelly, many grains with hematite coatings	45		370	
Pennsylvanian System				
Siltstone, calcareous, micaceous, greenish-gray	5		375	

join the ancient Mississippi Channel north of the city near Sankoty (fig. 12). The buried section of the valley was suggested on Udden's bedrock-surface map[47] as a broad tributary of the present valley, but was first indicated as a through-channel by Emery[48] in 1941. Since 1941 additional wells which support Emery's interpretation have been drilled along the channel.[49] The valley is entrenched on the east slope of the Pennsylvanian upland and isolates those sections of the upland east of the channel and west of Mackinaw Valley.

The valley is two to three miles wide and has been eroded in bedrock to a maximum depth of 275 feet below the bedrock upland to the west. The lowest bedrock elevation in the valley is 323 feet above sea-level, reported from a well near the south end of the buried section of the valley. Glacial deposits within the valley reach a possible maximum thickness of about 450 feet under the present upland and are about 120 feet thick along the present floodplain. The record of the Ebert-Buhler well, based on the study of sample well cuttings, is representative of the deposits overlying the buried portion of the valley. This and other similar records show that the valley was eroded in pre-Kansan and probably preglacial time and that characteristic Sankoty sand was deposited along the buried portion of the valley. This sand has never been reported from wells drilled along the narrows of the present valley.

Narrows of present valley.—The youngest section of the present valley, between Peoria and East Peoria, forms a narrow trench separating two segments of the island-like upland east of the Pekin-Sankoty channel. Rock benches occur along both sides of the present valley in this section, so that the channel below the 400-foot contour is less than one-half mile wide. The lowest reported bedrock along the channel is 363 feet above sea-level or about 40 feet higher than the Pekin-Sankoty Valley to the west. North of East Peoria the bedrock valley widens and merges with Mackinaw

[47]Op. cit., U. S. Geol. Survey Bull. 506.
[48]Emery, K. O., Electrical earth-resistivity survey at Peoria and vicinity: Illinois Geol. Survey unpublished manuscript, fig. 2, 1941.
[49]Horberg, Leland, Illinois Geol. Survey unpublished manuscript, 1946.

M. Ebert-Buhler Memorial Home Well, NE. 1/4, SE. 1/4, sec. 29, T. 9 N., R. 8 E., Peoria County
Elevation 666 feet

	Thickness Ft.	*Depth* Ft.
Pleistocene System		
Wisconsin glacial drift		
Loess	10	10
Till, calcareous, gray with pink tint	115	125
Illinoian glacial drift		
Till, sandy, calcareous, partly oxidized, gray to buff	35	160
Sand, medium to fine	45	205
Sand, gravelly	20	225
Sankoty sand		
Sand, medium to coarse, numerous polished red and pink grains, some gravelly beds	88	313
Pennsylvanian System		
Shale, micaceous, gray to black	4	317 total depth

Valley. The valley-fill reaches a maximum thickness of about 80 feet and is composed of alluvial silt and sand containing gravelly lenses, underlain by cleaner sand and gravel deposits which appear to be a glacial outwash.

Kickapoo Creek Bedrock Valleys.—Two bedrock valleys related to present Kickapoo Creek are intimately involved in the drainage history of the area. The larger and deeper bedrock channel coincides with the west branch and lower course of the present stream and enters Pekin-Sankoty Valley northwest of Peoria; the other bedrock valley is about five miles to the north and, although in part roughly parallel to upper Kickapoo Creek, it is for the most part completely buried by drift. As interpreted on the bedrock-surface map, the two valleys are connected by a spillway 500 to 550 feet above sea-level. In preglacial time the main valley appears to have been occupied by a stream which flowed eastward from southwestern Knox County across present Spoon River and through a buried valley south of Elmwood into the present Kickapoo Valley.

Possible Drainage History

In preglacial time the ancient Mississippi is believed to have flowed south through Mackinaw Valley. Kickapoo Creek at this time probably turned south at the mouth of the present valley through the Pekin-Sankoty channel and entered Mackinaw Valley south of Pekin in central Mason County. As a corollary the north Kickapoo bedrock valley is considered an independent tributary that was separated from the south Kickapoo Valley by a low col representing the northern buried portion of the Pekin-Sankoty channel.[50] This drainage probably existed until the advance of Nebraskan ice from the west which blocked the ancient Mississippi Valley to the south with drift and caused the valley to be alluviated with Sankoty sand to a possible minimum elevation of 560 feet.

Subsequent early Pleistocene drainage is obscure; after alluviation of the bedrock valleys by Sankoty sand it is uncertain whether the ancient Mississippi re-occupied a part of Mackinaw Valley or flowed southward through the Pekin-Sankoty channel. Both channels may have been in use at various times, as the time lapse was long and appears to represent most of the early Pleistocene. There is no evidence, however, that the valleys were cut down to their former levels during these stages. Instead, the available elevations of the top of the Sankoty sand, which are above 500 feet in both valleys, suggest that a high baselevel was maintained, at least until Sangamon time.

As the result of Illinoian glaciation the Yarmouth landsurface was buried below

[50]The low bedrock elevations along the col, possibly as low as 350 feet above sea-level, require special explanation, and two alternative interpretations suggest themselves: (1) The preglacial Wyoming Valley which enters an abnormally wide section of the main valley in northern Peoria County may have continued south and eroded the Pekin-Sankoty channel in preglacial time, and later the narrow divide separating it from the main valley to the east was largely eroded away: or (2) there may have been diversion of the ancient Mississippi into the Pekin-Sankoty channel prior to deposition of Sankoty sand so that at the time of sand deposition both Mackinaw Valley and the Pekin-Sankoty channel were open. There is little to support the second alternative. The first alternative, however, is suggested by the low bedrock hills just north of Peoria, the low bedrock ridge east of the mouth of Wyoming Valley near Chillicothe, and the abnormal width of the valley between Peoria and Chillicothe.

a cover of drift, and the region emerged as a gently sloping drift-plain. As indicated by Sangamon soil elevations, the drift-plain sloped toward the Pekin-Sankoty channel, and the present Illinois River was probably established along the lowest part of this surface. The present valley thus combines the exhumed southern part of the Pekin-Sankoty channel and a new valley superimposed from the Illinoian drift-plain. Preglacial Kickapoo Valley apparently was not buried completely and re-occupied. During the Wisconsin stage the valley at and above Peoria was again filled with till and again re-excavated, so that younger Wisconsin outwash now forms high terraces within the present valley and its tributaries.

ANCIENT ROCK RIVER SYSTEM

Location and Regional Relations

Rock River enters Illinois in northeastern Winnebago County and continues within its preglacial valley to the westward bend of the river south of Rockford where it leaves the old valley and turns southwest into a narrow rock gorge of more recent origin. The preglacial valley, partially filled with drift, continues southeast from this point as a prominent physiographic feature and is occupied by present Kilbuck Creek. In southeastern Ogle County the valley is blocked and completely buried by the Bloomington moraine, beyond which it continues as buried Pawpaw Valley south to Pawpaw in southeastern Lee County. At Pawpaw the valley is joined by Troy Valley and swings southwest to enter Princeton Valley above Princeton in north-central Bureau County (pls. 1 and 2). Except for important changes in the location of the buried portion of the valley, this is essentially the course proposed by Leverett[51] and adopted by subsequent writers.[52]

As shown by table 3, the bedrock floor of the valley ranges in elevation from 520 feet above sea-level at Janesville, Wisconsin, to 328 feet just below its mouth at Princeton, Illinois. On the basis of these figures the average gradient is about 1.58 feet per mile.

The valley can be traced northeastward into Wisconsin for about 100 miles where it constitutes the master drainage line of the region (fig. 20, p. 98). Beyond Janesville about 15 miles north of the state-line the valley is buried by Wisconsin drift and is known only from subsurface data. The major tributary from the northwest, Yahara bedrock valley, heads in the vicinity of Madison[53] and is closely followed by Yahara River.

Upper Rock River Valley

description

The Upper Rock River Valley is two to four miles wide and is entrenched in the Galena bedrock upland to an average depth of about 350 feet. The valley walls and adjoining uplands are underlain by the resistant Galena-Platteville dolomite so that sharp slopes and narrow steep-gradient tributaries are characteristic features. The valley is floored by the weaker St. Peter sandstone. There appears to be no relation to rock structure, as the valley is situated on the east flank of the Wisconsin arch (fig. 19) and crosses east-west trending secondary folds at essentially right angles. Glacial deposits partially filling the valley range in thickness from 200 to 350 feet and are composed largely of Wisconsin, Illinoian, and possibly older sand and gravel with minor amounts of silt and clay.[54] South of Rockford considerable thicknesses of early Wisconsin till are present.

Locally at Rockford[55] and South Beloit the present river is superimposed from drift across rock spurs along the west edge of the valley and has eroded narrow rock gorges.

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[51]Op. cit., Mon. 38, pl. XII, p. 130.

[52]Salisbury, R. D., and Barrows, H. H., The environment of Camp Grant: Illinois Geol. Survey Bull. 39, pp. 45-47, 1918.

Bretz, J Harlen, Geology and mineral resources of the Kings quadrangle: Illinois Geol. Survey Bull. 43, pp. 282-83, 1923.

Knappen, R. S., Geology and mineral resources of the Dixon quadrangle: Illinois Geol. Survey Bull. 49, pp. 98-101, 1926.

Rolfe, Deete, The Rock River country of northern Illinois: Illinois Geol. Survey Educ. Series No. 2, 59 pp., 1929.

[53]Alden, W. C., Quaternary geology of southeastern Wisconsin: U. S. Geol. Survey Prof. Paper 106.

[54]Possible pre-Illinoian outwash is noted by Buell, I. M., Boulder trains from the outcrop of the Waterloo quartzite area: Trans. Wisconsin Acad. Sci. vol. 10, pp. 485-509, 1895; Leverett, op. cit., Mon. 38, pp. 109--114; Bretz and Leighton in Bretz, op. cit., pp. 232-34. See page 108 of the present report for log of deposits at Rockford.

[55]Workman, L. E., The preglacial Rock River Valley as a source of groundwater for Rockford: Trans. Illinois Acad. Sci., vol. 30, pp. 245-47, 1937.

Table 3.—Bedrock Elevations Along the Ancient Rock River Valley System

Location	Distance, miles	Present ground-surface, feet above sea-level	Bedrock, feet above sea-level	Drift thickness, feet
Upper Rock River Valley				
Janesville, Wisconsin	0	870	[a]520	350
Beloit, Wisconsin (Wis. Power & Light)	13	750±	512	238±
Rockford, Winnebago Co., Illinois, sec. 35, T. 44 N., R. 1 E.	18	730	445	285
Mouth of Leaf-Stillman bedrock valley, Ogle Co., sec. 20, T. 42 N., R. 1 E.	10	770	485	285
Buried Pawpaw Valley				
Creston, Ogle Co., sec. 24, T. 40 N., R. 2 E.	16	890	505—	385+
Sec. 14, T. 38 N., R. 2 E., Lee Co.	11	912	552—	360+
Sec. 36, T. 38 N., R. 2 E., Lee Co.	4	800±	381—	419+
Pawpaw, sec. 10, T. 37 N., R. 2 E., Lee Co.	3	928	474	454
Sublette, sec. 9, T. 19 N., R. 11 E., Lee Co.	14	920	497	423
Sec. 9, T. 18 N., R. 10 E., Bureau Co.	8	820	425	395
Sec. 7, T. 18 N., R. 9 E., Bureau Co.	8	870	370±	500±
Sec. 6, T. 17 N., R. 9 E., Bureau Co.	5	720	371—	349+
Princeton Valley at Princeton	8	700	328	372
Buried Troy Valley				
Troy Twp., Walworth Co., Wisconsin	0	881	[b]480	401
Delavan, Walworth Co., Wisconsin	14	900	[b]485	415
Sec. 8, T. 46 N., R. 5 E., McHenry Co., Illinois	6	930	530	400
Capron, sec. 11, T. 45 N., R. 4 E., Boone Co.	8	910	610±	300±
Belvidere, sec. 22, T. 44 N., R. 3 E., Boone Co.	11	770	514	256
Sec. 22, T. 43 N., R. 2 E., Winnebago Co.	8	790	525—	265+
Sec. 36, T. 41 N., R. 3 E., DeKalb Co.	16	870	525—	345+
Shabbona, sec. 22, T. 38 N., R. 3 E., DeKalb Co.		860	490	370

[a] Chamberlin, T. C., Geology of Wisconsin, vol. II, p. 166, 1877.
Alden, W. C., Quaternary Geology of southeastern Wisconsin: U. S. Geol. Survey Prof. Paper 106, p. 114, 1918.
[b] Op. cit., p. 123.

TRIBUTARIES

Pecatonica Valley.—This important tributary enters Rock River valley from the west at Rockton in northern Winnebago County. It is the trunk stream of a large asymmetrical drainage basin which extends west into Jo Daviess County and north into Wisconsin to the crest of the Galena cuesta along Military Ridge. Its main tributaries in Illinois are from east to west: Sugar River, Richland Creek, and Yellow Creek. Physiographically the drainage pattern is significant because, if the present valley below Freeport and Yellow Creek valley combined is considered the axial drainage line, all important tributaries flow down dip from the north as resequent streams, whereas obsequent tributaries from the south are short and poorly developed. The axial valley, however, is not truly subsequent in that it crosses the Wisconsin arch and is entrenched in the Galena dolomite rather than localized along a zone of weak bedrock.

The larger valleys have an average width of about a mile and lie 200 to 300 feet below the bedrock upland. Glacial deposits filling the valleys reach a maximum thickness of more than 250 feet and are composed largely of Illinoian and possibly older glacio-fluvial and lacustrine deposits with minor amounts of till. Wisconsin outwash extends up the valley for some distance but is of subordinate importance. The area as a whole is so thinly covered by Peorian loess and Illinoian till that preglacial valleys were re-occupied following glaciation.[56]

[56]The following references deal with glacial deposits in the region: Hershey, O. H., The Columbia formation in northwestern Illinois: Am. Geologist, vol. 15, pp. 7-24, 1895; Early Pleistocene deposits of Northern Illinois: Am. Geologist, vol. 17, pp. 287-303, 1896; The Silveria formation: Am. Jour. Sci., 4th ser., vol. 2, pp. 324-30, 1897; Eskers indicating stages of glacial recession in the Kansan epoch in northern Illinois: Am. Geologist, vol. 19, pp. 197-209, 237-53, 1897; The Florencia formation, Am. Jour. Sci., 4th ser., vol. 4, pp. 90-98, 1897; Mode of formation of till as illustrated by the Kansan drift of northern Illinois: Jour. Geology, vol. 5, pp. 50-62, 1897. Leverett, Frank: op. cit., Mon. 38, pp. 80-84, 109-118.

The only major drainage change was the piracy of the upper valley of Yellow Creek by Apple River, previously described (p. 46). A number of minor drainage changes related to the Illinoian glaciation are evidenced by local burial of preglacial valleys and erosion of the rock gorges[57] (pl. 1) listed below:

1. Small rock gorge and abandoned valley one mile north of Freeport, secs. 19 and 30, T. 27 N., R. 8 E. Shown on the Freeport quadrangle map.
2. Rock gorge at Cedarville along Cedar Creek (sec. 36, T. 28 N., R. 7 E., and sec. 31, T. 28 N., R. 8 E.). The preglacial valley, partially drift-filled, lies about a mile to the south. Shown on the Freeport quadrangle map.
3. Rock gorges and associated abandoned valleys of Pecatonica River in the SW. 1/4 of T. 28 N., R. 7 E. Shown on the Freeport quadrangle map.
4. Rock gorges along Yellow Creek between Pearl City and Freeport, secs. 13 and 14, T. 26 N., R. 6 E.; secs. 1, 2, 10, and 11, T. 26 N., R. 7 E. The partially buried preglacial valley lies about a mile to the south. Shown on the Freeport and Lena quadrangle maps.
5. Rock gorge and abandoned valley east of Stockton, N. 1/2, T. 27 N., R. 5 E. Shown on the Lena quadrangle map.

Leaf River Valley.[58]—Leaf River at present flows eastward in a preglacial valley across northern Ogle County and enters Rock River south of Byron. Beyond the mouth of the present stream the preglacial valley turns northeast following Rock River Valley to Byron where it continues east through abandoned Stillman Valley to ancient Rock River Valley. Tributary valleys now followed by Rock River entered the preglacial valley south of the present mouth of Leaf River and north of Byron (pls. 1 and 2).

Bluff Creek, which enters the Rock River narrows near the south edge of Winnebago County, is similar to Leaf River in that its preglacial valley crosses Rock River and continues southeast to the ancient valley.

Pawpaw Bedrock Valley

DESCRIPTION

The buried portion of old Rock River Valley is named Pawpaw Valley from the village of that name in southeastern Lee County in the vicinity of which a number of wells show that bedrock elevations are abnormally low. The course previously outlined and shown on plate 1 is quite closely controlled by subsurface data which would permit only minor variations in interpretation. It agrees essentially with the course proposed by Leverett and adopted by subsequent writers.[59] The only important change is the location of the valley in southeastern Ogle County just east of Creston rather than five miles or so to the west between Creston and Rochelle.

The upper valley in the Galena dolomite is not more than two to three miles in width, but it widens to six or eight miles near its mouth where the bedrock is weaker Pennsylvanian strata. Elevations along the valley floor range from about 340 to 410 feet above sea-level, which is 250 to 400 below adjoining bedrock uplands. The valley is transverse in relation to structure crossing two important structures, the Sandwich fault zone and the LaSalle monocline (fig. 19). In passing from north to south the valley floor probably consists of St. Peter sandstone, Cambrian dolomites and sandstones, Prairie du Chien dolomite, St. Peter sandstone, and Pennsylvanian strata composed largely of shale (fig. 7). The uplands adjoining the valley are underlain largely by Galena dolomite north of the LaSalle flexure and Pennsylvanian strata south of the flexure.

The glacial deposits filling and overlying Pawpaw Valley reach thicknesses of more than 600 feet in eastern Lee County and represent the thickest known Pleistocene sections in Illinois. Thick Wisconsin and Illinoian tills with interbedded sands and gravels are known to occur, and older drift may be present but unrecognized. Sand and gravel deposits appear to be thicker and more continuous below the Sangamon soil zone. Sankoty sand has been penetrated at the base of the drift in several wells along Pawpaw Valley in northeastern Bureau County. The log of the Mendota City well No. 3, based on study of sample cuttings, is an unusually complete record of the Pleistocene deposits in the area.

[57]Hershey, O. H., Pleistocene rock gorges of northwestern Illinois: Am. Geologist, vol. 12, pp. 314-23, 1893.
Leverett, op. cit., Mon. 38, pp. 493-96.

[58]Leverett, op. cit., Mon. 38, p. 485, pl. XII.
Bretz, J H., Geology and mineral resources of the Kings quadrangle: Illinois Geol. Survey Bull. 43, p. 283, fig. 69, 1923.

[59]See footnotes 51 and 52.

Layne-Western Co.—City of Mendota No. 3, 320 feet south, 1280 feet west of NE corner, sec. 33, T. 36 N., R. 1 E., LaSalle County
Elevation 760 feet A.T.

	Thickness Ft.	*Depth Ft.*
Wisconsin drift		
Till, calcareous, oxidized, yellow	10	10
Till, calcareous, gray	60	70
Till, calcareous, brownish-gray	10	80
Sangamon soil		
Soil, clayey, leached, dark gray, abundant humus	10	90
Illinoian drift		
Till, leached, oxidized, green	5	95
Till, calcareous, oxidized, yellowish-brown	15	110
Gravel, up to 1 inch, sandy	10	120
Sand, medium, gravelly, slightly silty	15	135
Gravel, up to ½ inch, sandy, silty	20	155
Till, calcareous, gravelly, brownish-gray	15	170
No sample	15	185
Sand, medium, and silt, calcareous	10	195
Yarmouth soil		
Soil, silty, sandy, leached, dark brown	15	210
Kansan (?) drift		
Gravel, up to ½ inch, sandy, partly oxidized, clean	25	235
Gravel, granular, sandy, partly oxidized, clean	5	240
Pre-Kansan Sankoty (?) sand		
Sand, medium, some gravel, some oxidized dolomite grains, over 90 percent quartz	20	260
"Sand, white, fine, medium"	7	267
Platteville dolomite		

TRIBUTARIES

Several short tributaries on both sides of the valley are indicated by the available records. Actually these tributary systems are probably much more complex than shown (pls. 1 and 2). Only one tributary, Kyte River bedrock valley, is of regional importance.

Kyte River Bedrock Valley.[60]—This preglacial valley heads near the crest of the Galena bedrock upland in west central Ogle County and extends southeastward across present Rock River to join buried Pawpaw Valley near the northeast corner of Lee County. The present Kyte River follows the reversed course of the practically buried valley southeast of Rock River.

Troy Bedrock Valley

The presence of a major bedrock valley east of the ancient Rock River Valley was first recognized in Wisconsin by Alden[61] who named the valley from the towns of Troy and East Troy in northeastern Walworth County. The valley heads in the Niagara cuesta about 50 miles north of the state-line (fig. 20, p. 98) in the vicinity of Waukesha and continues south along the front of the escarpment into Illinois as a strike valley in the Maquoketa shale. After entering the State in the northwest corner of McHenry County (pls. 1 and 2) the valley appears to continue southwest across Boone County along the same general course as Piscasaw Creek to Belvidere. From Belvidere south for a distance of 20 miles the valley, like ancient Rock River Valley to the west, is not completely drift-filled and is occupied by Kishwaukee River and its south branch.[62] South of Boone County the valley is blocked and completely buried by Tazewell moraines of the Wisconsin stage, and the location of the valley is determined entirely from subsurface data. These data indicate that the buried valley extends south through DeKalb County, separated from ancient Rock River Valley to the west by only a narrow peninsular upland, and enters the master

[60]Leverett, op. cit., Mon. 38, pl. 12, p. 486.
Knappen, R. S., Geology and mineral resources of the Dixon quadrangle: Illinois Geol. Survey Bull. 49, pl. 4, p. 99, 1926.
[61]Alden, W. C., The Delavan lobe of the Lake Michigan glacier of the Wisconsin stage of glaciation and associated phenomena: U. S. Geol. Survey Prof. Paper 34, pp. 16-18, pl. II, 1918.

[62]Shown on the Kirkland quadrangle map.

valley in the southwestern corner of the county.[63]

This interpretation of the buried lower section of the valley was adopted for the following reasons: (1) Well records indicate the presence of low bedrock along the proposed course; (2) the narrow bedrock upland separating the valley from Rock River is prominent physiographically to the north,[64] and its buried southern continuation as an unbroken ridge at least as far south as Malta is evidenced by numerous records; (3) the bedrock upland east of the proposed valley slopes westward, and if the valley were not present it would have to rise abruptly over the higher upland to the west; (4) alternative interpretations necessitate narrows and abrupt turns and embarrassingly low elevations near the headwaters of short tributaries. There are two positions along the ridge at which a cross valley might be contoured to permit various alternative hypotheses: One of these is south of Malta in the south half of T. 40 N., R. 3 E. and the other is west of Shabbona in the north half of T. 38 N., R. 3 E.

The valley is similar to ancient Rock River in size and in its structural relations. It has an average width of two to three miles and is entrenched to elevations less than 500 feet above sea-level, which is 200 to 350 feet below adjoining uplands. Although it is possibly a strike valley in Wisconsin, in Illinois the valley lies west of the Maquoketa shale and is entrenched in the Galena dolomite. Below Boone County the valley is probably floored by St. Peter sandstone south to Shabbona in southern DeKalb County where Cambrian rocks on the southwest side of the Sandwich fault zone (fig. 8) are encountered.

The glacial deposits overlying the valley reach thicknesses of more than 500 feet near the state line and are 250 to 400 feet thick in areas to the south. From the limited data available it appears that, except for thick outwash along Kishwaukee River, the glacial deposits consist dominantly of till with sand and gravel beds of moderate thickness. The presence of Wisconsin, Illinoian, and possibly older drift is indicated by the few detailed records available.

Present Rock Gorge of Rock River

The recent narrow valley of Rock River across the Galena Upland between the mouth of the Kishwaukee and Dixon is one of the outstanding scenic areas in the State and is well known from previous publications.[65] Only the outstanding drainage features are summarized below.

Rock River leaves the large preglacial valley a few miles south of Rockford in southern Winnebago County and for 50 miles follows a gorge-like valley that is eroded largely in Galena-Platteville dolomite and St. Peter sandstone. The narrows terminate near the west edge of Lee County where the river enters the Green River Lowland. The valley in most places is less than a mile wide and 100 to 150 feet deep. The only glacial deposits within the recent channel are valley-trains of Wisconsin age.

In terms of preglacial topography the valley from northeast to southwest extends: (1) Across a narrow rock ridge, (2) up a west tributary of preglacial Bluff Creek, (3) across a divide, (4) down a north trib-

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[63] This course of the Troy Valley in Illinois differs from earlier interpretations. Leverett in U. S. Geol. Survey Mon. 38, p. 485, recognized the existence of a preglacial valley in the area and states that Kishwaukee River "is in a new course for a few miles below the junction of the north and south branches. It is not clear whether the old mouth was a short distance north of the present mouth or whether the stream passed southward up the south branch to the vicinity of Fielding and thence across to the old Rock River Valley near Esmond. The north and south branches each occupy a preglacial valley for a few miles above their junction, but the headwater portions of each stream are in new valleys."

Alden, U. S. Geol. Survey Prof. Paper 34, p. 123, after discovering Troy Valley in Wisconsin suggested that "the further extension of the Troy Valley is doubtless to be found extending beneath Bigfoot Prairie southward through the western part of McHenry County, Ill., just west of Harvard, and thence down Rush Creek valley to the Kishwaukee." The inference is that beyond this point the valley followed one of the two courses suggested by Leverett.

This course of the valley lies considerably east of that proposed by the writer and is untenable in the light of records now available. The buried portion of the valley in DeKalb County was unknown to Leverett and Alden, but later was recognized and named "Shabbona tributary" of old Rock River Valley by L. T. Caldwell in "A study of the stratigraphy and the preglacial topography of the DeKalb and Sycamore quadrangles": Unpublished master's thesis, University of Chicago, pp. 8-9, 1936. The study is significant in locating buried "Shabbona" (Troy) valley, but other interpretations suffer because of the erroneous belief that ancient Rock River Valley lay west of the area instead of along its western margin.

[64] Shown on the Kings and Belvidere quadrangle maps.

[65] See footnotes 51, 52, p. 62.

utary of preglacial Leaf River, (5) up preglacial Leaf River valley, (6) up a south tributary of preglacial Leaf River, (7) across a divide, (8) across Kyte preglacial valley and adjoining lowlands, (9) across a rock divide, (10) down a north tributary of preglacial Pine Creek, (11) up preglacial Pine Creek valley, (12) across a divide, and (13) down an east tributary of preglacial Elkhorn Creek into the Green River bedrock lowland (pls. 1 and 2).

Drainage History

Following the entrenchment of preglacial valleys in late Tertiary or early Pleistocene time the first major event for which there is clear evidence is the Illinoian glacial invasion from the east which brought about diversion of Rock River and most of the other drainage changes in the area. There is indirect evidence of an earlier glaciation[66] which either reached, or more probably, approached the area from the east but there is no indication that important drainage changes resulted from it.

During the advance and retreat of the Illinoian glacier, a complex series of drainage lines on and marginal to the ice doubtless existed, as evidenced by widespread glacio-fluvial deposits,[67] and thick varved lake silts were deposited in the Pecatonica basin[68] and possibly elsewhere. Either during the retreat of the ice or immediately following, Rock River established its course through the narrows below Byron, the old valley to the southeast and its western tributaries having been blocked. The course through the narrows above Byron was caused by obstruction of the post-Illinoian (Sangamon) channel through Stillman Valley by early Wisconsin ice,[69] otherwise no significant drainage changes occurred during the Wisconsin glaciation.

[66]Hershey, O. H. Early Pleistocene deposits of northern Illinois: Am. Geologist, vol. 17, pp. 287-303, 1896

Buell, I. M., Boulder trains from the outcrop of the Waterloo quartzite area: Trans. Wisconsin Acad. Sci., vol. 10, pp. 485-509, 1895.

Leverett, Frank, op. cit., Mon. 38, pp. 109-114.

Bretz, J H., op. cit., pp. 232-34.

Knappen, R. S., op. cit., pp. 94-95.

[67]These occurrences are summarized by Flint, R. F., Glaciation in northwestern Illinois: Am. Jour. Sci., vol. 21, 5th ser., pp. 422-40, 1931, who regarded them as evidence of ice stagnation.

[68]Hershey, O. H., op. cit., and Leverett, Frank, op. cit.; see also footnote 56, p. 63.

[69]Bretz, op. cit., fig. 70, p. 283.

MAHOMET (TEAYS) BEDROCK VALLEY SYSTEM

Location and Regional Relations

One of the largest buried valleys in the central lowland enters Illinois from the east near the southeastern corner of Iroquois County, and with a broad southward loop continues westward for 120 miles to enter the Lower Illinois bedrock valley in southern Tazewell County (pl. 1). Much of central and northeastern Illinois in preglacial time was drained by this valley and its large northern tributary, Kempton-Newark Valley. The valley was named[70] from the village of Mahomet in western Champaign County (T. 20 N., R. 7 E.) where three wells encounter rock at low elevations and determine the position of the deep part of the channel.

The possible regional relationships of the valley are of unusual interest because well records and outcrop data indicate that the valley continues eastward into an ancient buried valley in Indiana which is believed to be the course of the ancient Teays River. On this basis it was proposed that Mahomet Valley represents the lower course of a master preglacial stream which had its source near the eastern scarp of the Blue Ridge in North Carolina, flowed westward, across Ohio, northern Indiana, and central Illinois and finally discharged into the gulf embayment through the ancient Mississippi valleys along the lower Illinois and Mississippi rivers (fig. 20, p. 98).[71] In its broad regional relations this ancient drainage system encompassed much the same watershed as the present Ohio and may be considered the preglacial ancestor of that stream.

Mahomet Bedrock Valley

Description.—The presence of unusually low bedrock elevations in central Illinois

[70]Horberg, Leland, A major buried valley in east-central Illinois and its regional relationships: Jour. Geology, vol. 53, pp. 349-59, 1945; Illinois Geol. Survey Rept. Inv. 118, 1946.

[71]The evidence for the course of the ancient Teays east of Illinois and a review of previous literature may be found in Horberg, Leland, op. cit., and Fidlar, M. M., The preglacial Teays valley in Indiana: Jour. Geology, vol. 51, pp. 411-18, 1943.

Table 4.—Bedrock Elevations along the Ancient Mahomet (Teays) and Lower Mississippi Systems

Location	Distance, miles	Present ground-surface, feet above sea-level	Bedrock, feet above sea-level	Drift thickness, feet
Teays Valley				
Scary, West Virginia			[a]670	
Chillicothe, Ohio			[a]630	
Madison Co., Ohio			[b]538—	
Jay Co., Indiana			[c]463	
LaFontaine, Wabash Co., Indiana			[d]410±	
Miami Co., Indiana			[e]423	
Delphi, Carroll Co., Indiana			[e]360±	
LaFayette, Indiana			384	
Oxford, Benton Co., Indiana			[f]300	
Mahomet Valley (Illinois)				
Rankin, Vermilion Co.	0	718	358	360
Paxton, Ford Co.	5	790	[g]343	447
Mahomet, Champaign Co.	40	692	362	330
Clinton, DeWitt Co.	35	714±	340—	374
Delavan, Tazewell Co.	36	610	[g]288	322
Lower Illinois Valley				
Beardstown, Cass Co.	50	447	311	136
Sec. 24, T. 15 N., R. 14 W., Scott Co.	24	437	333	104
Sec. 32, T. 11 N., R. 13 W., Greene Co.	25	429	329	100
Sec. 1, T. 8 N., R. 14 W., Jersey Co	16	427	277	150
Lower Mississippi Valley (Illinois)				
Hartford, Madison Co.	40	428	308—	120+
Monks Mound, East St. Louis, St. Clair Co.	13	416	266	150
Sec. 13, T. 1 S., R. 11 W., Monroe Co.	15	416.30	[h]256.75	159.55
Sec. 36, T. 4 S., R. 11 W., Monroe Co.	25	380	[h]238.4	141.6
Sec. 27, T. 6 S., R. 8 W., Randolph Co.	19	390	[h]222.4	167.6
Wagners Landing, sec. 4, T. 9 S., R. 5 W., Jackson Co.	22	374.8	[h]207.6	167.2
Fountain Bluff, sec. 2, T. 10 S., R. 4 W., Jackson Co.	10	340	[h]182.3	157.7
Wolf Lake, sec. 4, T. 12 S., R. 3 W., Union Co.	14	356.1	[h]213.08—	143.02+
Above Thebes, sec. 36, T. 14 S., R. 4 W., Alexander Co.	20	330	[h]191.5	138.5
Above Cairo, sec. 2, T. 17 S., R. 2 W., Alexander Co.	18	300	[h]163.3—	136.7+

Unless otherwise noted records are from the files of the Illinois State Geological Survey.
[a] Stout, Wilbur and Lamb, G. F., Physiographic features of southeastern Ohio: Ohio Jour. Sci., vol. 38, 1939; Geol. Survey of Ohio, Reprint Series No. 1, p. 14, 1939.
[b] VerSteeg, Karl, The buried topography of western Ohio: Jour. Geology, vol. 44, p. 925, 1936.
[c] Fidlar, op. cit., p. 416.
[d] Capps, S. R., Underground waters of north-central Indiana: U. S. Geol. Survey Water-Supply Paper 254, p. 26, 1910.
[e] Logan, W. N., The subsurface strata of Indiana: Indiana Div. Geol., Publ. No. 108, p. 47, 1931.
[f] Leverett, Frank, The preglacial valleys of the Mississippi and it tributaries: Jour. Geology, vol. 3, p. 757, 1895.
[g] Savage, T. E., On the geology of Champaign County: Trans. Illinois Acad. Sci., vol. 23, pp. 444-45, 1931.
[h] U. S. Army Corps of Engineers: Mississippi River from St. Louis, Mo. to Cairo, Ill. in 17 charts made under direction of the Board on Examination and Survey of Mississippi River created by River and Harbor Act of March 2, 1907, 1908.

and the possible existence of a major buried valley leading eastward from Illinois Valley has long been recognized, but it was not until recently that sufficient data were available to determine its approximate position and probable regional relationships.[72]

Rock elevations along the valley are less than 400 feet above sea-level, or 200 to 300 feet below adjoining bedrock uplands. The width of the minor channel appears to be about four miles near the state-line, five miles in central Piatt County, and about

[72]The earliest geological studies in the area made by F. H. Bradley of the Worthen Survey revealed low bedrock elevations at several points in central Illinois; "Geology of Kankakee and Iroquois counties," in Geology and Paleontology: Geological Survey of Illinois, vol. IV, pp. 226-40, 1870; "Geology of Champaign, Edgar and Ford counties," Idem, 266-75. The distribution of these low points led Bradley to postulate that a preglacial valley extended southward from Lake Michigan through Kankakee and eastern Iroquois counties into Champaign County and thence northwestward under the city of Bloomington into Illinois Valley in southern Tazewell County. It is now known that these low points lie within independent drainage systems. Frank Leverett confirmed the presence of low rock elevations and suggested possible relations to the preglacial courses of Kaskaskia, Wabash, or Illinois rivers; "The preglacial valleys of the Mississippi and its tributaries:" Jour. Geology, vol. 3, pp. 744, 757, 1895; The Illinois glacial lobe: U. S. Geol. Survey Mon. 38, pp. 701-03, 654-64, 703-704, 704-07, 1899. Later H. M.

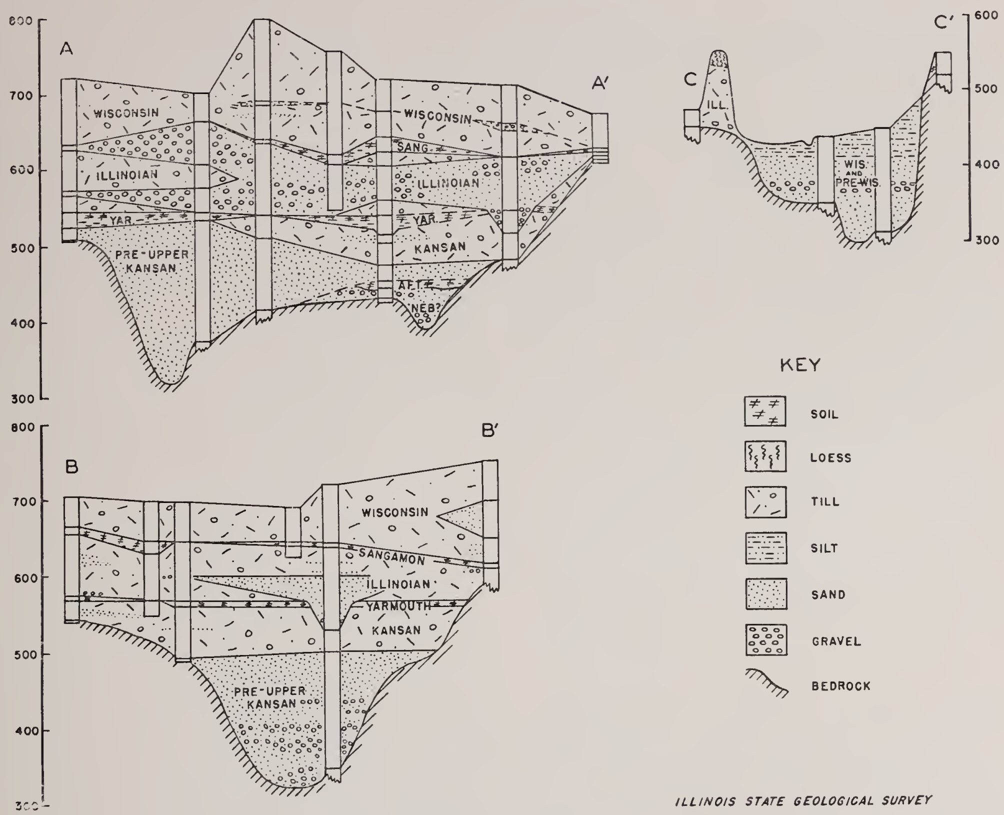

FIG. 13.—Cross-sections of glacial deposits in east-central Illinois.

15 miles in DeWitt County. A notable widening suggestive of floodplain development is thus indicated for the downstream portion of the valley. There is also a suggestion that the valley may have been eroded during two cycles so that the valley is entrenched below a broad outer valley, 500 to 600 feet above sea-level.

The descent of the valley floor (table 4) appears to be gradual and has an estimated average gradient of 1.65 inches per mile between Oxford, Indiana, and the Lower Illinois bedrock valley.

Two alternative interpretations of the upper course of the valley could be suggested on the basis of existing data: (1) There may be a low divide near the northern boundary of Champaign County so that the portion of the valley to the east drained eastward into the Wabash rather than westward; (2) there may be a low divide near the state line so that Mahomet Valley did not extend into Indiana. By both interpretations major valleys would end abruptly without important headwater tributaries. The first alternative is further discounted by the northwest trend of the valley north of Danville (pl. 1) indicating drainage to the west and by a record showing bedrock less than 380 feet above sea-level in the northwest part of Champaign County. The major objection to the second alternative is the unusually low bedrock just across the state line in southern Benton County, Indiana.

The valley transgresses regional structural trends and, from east to west, crosses

Clem, in "The preglacial valleys of the upper Mississippi and its eastern tributaries:" Proc. Indiana Acad. Sci., 1910, pp. 335-52, 1911, suggested that a "spur" connected Illinois and Wabash bedrock valleys; and T. E. Savage, "On the geology of Champaign County:" Trans. Illinois Acad. Sci., vol. 23, pp. 444-45, 1931, definitely related the preglacial drainage of the region to Illinois bedrock valley. Within recent years L. E. Workman and George E. Ekblaw of the Illinois State Geological Survey, in unpublished maps and cross-sections, outlined the eastern margin of the valley in Champaign County and made subsurface interpretations of the glacial deposits; and Horberg, op. cit., discussed the possible regional relationships of the valley in a report preliminary to the present investigation.

the western Indiana syncline, the LaSalle uplift, and the northern part of the Illinois basin (fig. 8).

Valley-Fill.—Eleven units of Pleistocene deposits have been identified in sample cuttings from wells in the area:

11) Post-Shelbyville (Wisconsin) till and outwash
10) Shelbyville (Wisconsin) till
9) Sangamon soil and alluvium
8) Upper Illinoian till
7) Middle Illinoian sand and gravel
6) Lower Illinoian till
5) Yarmouth soil and alluvium
4) Kansan till
3) Kansan sand and gravel
2) Aftonian alluvium
1) Nebraskan (?) sand and gravel

Within this sequence significant unconformities occur at the base of the Kansan sand and at the bases of the Yarmouth and the Sangamon interglacial deposits (fig. 13). These unconformities are responsible for major variations in the succession below the Sangamon soil zone; the Wisconsin tills form a relatively regular unit in which Shelbyville and post-Shelbyville divisions are usually recognizable. An outstanding feature of the pre-Wisconsin deposits is the dominance of waterlaid silts, sands, and gravels within Mahomet Valley in contrast to glacial till which is the dominant material along the margin of the valley and under the adjoining uplands (cross-sections, A-A′ and B-B′, fig. 13).

Relations of the Sangamon and the Yarmouth Soil Zones.—The Sangamon plain below Wisconsin drift has been reconstructed for a part of the area on the basis of about 200 well records in which buried soil was either logged by the driller or was determined from sample cuttings.[73] The plain slopes gently away from the bedrock upland in McLean County and crosses Mahomet Valley without significant change in gradient (cross-section A-A′ and B-B′, fig. 13). In Macon, Piatt, and western Champaign counties most of the elevations fall between 620 and 640 feet above sea-level. The surface has an average gradient of about 5 feet per mile and ranges in elevation from 760 to 590 feet above sea-level. In northwestern Champaign County a shallow sag in the plain lies approximately over Mahomet Valley, but elsewhere there is no coincidence with the bedrock surface.

The Yarmouth surface is not as well known as the Sangamon, but it appears to cross Mahomet Valley at fairly uniform elevations (cross-sections A-A′ and B-B′, fig. 13). About 60 wells in the area encounter the horizon and indicate a general parallelism with the Sangamon surface. Highest elevations occur over the bedrock upland in McLean County, and from that area the Yarmouth surface slopes outward in all directions. Elevations range from 570 to 514 feet above sea-level, the majority falling between 550 feet to 600 feet.

Tributaries

Kempton-Newark Bedrock Valley.—The buried Kempton-Newark Valley enters Mahomet Valley near Paxton in southern Ford County and is the only important tributary from the north. It is believed to follow a broad and complex subsequent lowland that was developed largely on the Maquoketa and Pennsylvanian shales lying west of the Niagara cuesta in northeastern Illinois. As previously noted, the upper Newark section of the valley is separated from Kempton Valley on the south by Pleistocene channeling along upper Illinois River, and during the Kansan-Wisconsin interval it probably drained westward through River Ticona. Because of this and the uncertainties in interpretation the hyphenated term is used.

Newark Valley heads within the frayed margin of the Niagara escarpment in northeastern Kane County and continues southward on the Maquoketa shale to western Kendall County where the valley crosses the Galena dolomite and St. Peter sandstone before entering the Pennsylvanian lowland in northern Grundy County (fig. 7). An important tributary from the north enters the valley near the northeast corner of Kendall County. The main valley has an average width of about a mile and is 100 to 150 feet deep. A possible alternative interpretation that the valley extended westward from Kendall County to join ancient Rock River Valley near the southwest corner of DeKalb County is opposed

[73]Horberg, Leland, op. cit.

by the presence of the broad Newark lowland to the south and by the necessity of crossing an upland area to the west.

In northern Grundy County the valley widens into a broad shallow lowland on Pennsylvanian shales which is continued southward by Kempton Valley. The important tributaries head within the Niagara escarpment to the east and are represented by bedrock valleys along DuPage and Des Plaines rivers in Will County and by Onarga bedrock valley in Kankakee and Iroquois counties. Chatsworth Valley is the only important western tributary.

The glacial deposits which bury the valley vary greatly in thickness, depending on its position with respect to Wisconsin moraines. Actual figures would range from less than 50 feet in the Morris basin to over 400 feet in the lower part of the valley. Illinoian and possibly older drift is known to be present below the Wisconsin in Iroquois, Ford, and Livingston counties, but in general there is little information available on the age and composition of the deposits.

Danville Bedrock Valley.—The preglacial Danville Valley enters the State in southern Vermilion County and passes northward through the city of Danville, entering Mahomet Valley near the north county line (pl. 1). In the vicinity of Danville the position of the valley is closely established by numerous well records and by the general absence of bedrock exposures east of Vermilion River and its North Fork. North of the Danville region the exact location of the channel is conjectural. The floor of the valley in Danville is about 440 feet above sea-level which is 150 feet below the upland on the west. Glacial drift overlying the valley varies in thickness from 100 to 350 feet and near Danville includes sand and gravel deposits up to 75 feet thick.

Pesotum Bedrock Valley.—Pesotum Valley heads west of the bedrock upland in southern Vermilion County and extends westward through Pesotum in southern Champaign to Mahomet Valley in central Piatt County. The bedrock valley is three to six miles wide and 100 to 200 feet deep. Several narrow and deep tributaries dissect the upland on the south in Douglas County.

The glacial drift overlying the valley reaches thicknesses of more than 350 feet and includes Wisconsin, Sangamon, Illinoian, and Kansan deposits. Thick Sangamon-Illinoian deposits of water-laid silt, sand, and gravel are known to be present. As in the case of Mahomet Valley, the Sangamon plain crosses the valley without interruption.

Minor Tributary Valleys.—Numerous minor tributaries are doubtless present but are poorly known because of lack of control. A fairly large tributary from the east is known to pass just south of Champaign-Urbana in central Champaign County. Smaller tributaries from the north enter the main valley in northwestern Champaign County and northwestern DeWitt County.

Drainage History

Mahomet Valley and its tributaries were eroded below the upland surface in pre-Aftonian time, as Aftonian and possibly Nebraskan deposits have been identified within the valley in cuttings from wells at Urbana, Champaign County (fig. 13, cross-section A-A′), and in southwestern McLean County. In both localities three soils are recognizable, the lowermost or Aftonian being underlain by sand and gravel. The age of the basal sand and gravel is uncertain and it is considered Nebraskan rather than Aftonian only because of the absence of humus, the pronounced break at the top of the deposit, and its general similarity to known glacial, rather than interglacial, deposits. Valley cutting thus appears to have been completed by preglacial Pleistocene time. Later modifications of the bedrock surface in the area were probably brought about largely by drainage diversions and only to a minor degree by true glacial erosion. Glacial erosion by Wisconsin ice was certainly negligible, as there are few instances where the surface drift is not underlain by Sangamon soils or weathered zones.

The dominant glacio-fluvial character of

the pre-Wisconsin deposits within Mahomet Valley indicates that the valley remained an active drainage line until late Illinoian time. During early Pleistocene time the channel was probably open and cleared of fill, as the pre-upper Kansan sand and gravel in several places rests directly on bedrock (cross-section A-A′ and B-B′, fig. 13). However, after the deposition of this material, the valley was progressively filled with glacial and interglacial deposits so that by Sangamon time, it had ceased to function as an important drainageway, and the Sangamon plain crossed it without interruption.

The available evidence indicates that the first drainage diversion leading to the abandonment of the valley was caused by the advance of the Kansan glacier, and that the valley continued only as a minor channelway during Yarmouth and Illinoian time. The possibility of diversion in pre-Kansan time is opposed by the occurrence of Aftonian and older deposits at elevations between 450 and 500 feet above sea-level within the valley and by the stratified character of all the valley deposits that lie below the upper Kansan till. The alternative of diversion by the Illinoian glacier finds some support in the widespread occurrence of middle Illinoian sand along the valley. However, the base of this sand has an elevation of about 550 feet above sea-level, which is 250 feet above the valley-floor and close to the level of much of the upland. This relation, together with the uniform elevation of the Yarmouth soil, suggests that the valley in Illinoian time was a broad sag which followed the general course of Mahomet Valley and received Illinoian outwash but was not an important through-valley. This view is further attested by the fact that the Yarmouth and Sangamon deposits consist largely of peaty soil and alluvial silt and fine sand, most of which probably represents wash from adjacent gentle till slopes.

With the advance of the Wisconsin glacier across the Sangamon plain, all vestiges of the old valley were erased and there is nothing in the present landscape to suggest its existence.

LOWER ILLINOIS VALLEY

Description

Two sections of the Illinois bedrock valley below Pekin are readily recognized: (1) An upper broad valley, the Havana lowland, which in part is eroded in Pennsylvanian shales and in part represents the stripped surface of the Meramec limestones; and (2) the lower narrow valley below Beardstown which is entrenched in the Meramec-Osage limestones (fig. 5 and pl. 1). These two sections of the bedrock valley are clearly reflected in the present topography,[74] although the eastern part of the Havana lowland is buried by Wisconsin (Tazewell) moraines.

As previously noted (p. 36), the Havana lowland is considered fundamentally a strath developed above the Beardstown baselevel during a preglacial cycle. However, like the Green River Lowland, it probably underwent important changes during the glacial period as a result of drainage modifications. These changes were caused largely by diversion of the ancient Mississippi into the Pekin-Sankoty channel and by the floods of Wisconsin meltwater which enlarged the northwestern part of the lowland and eroded a rock bench along the west edge of the lowland between Pekin and the mouth of Spoon River. The bedrock lowland has an average elevation of about 350 feet and is overlain by glacial deposits which have an average thickness of 150 feet and are composed largely of sand, gravel, and silt (cross-section C-C′, fig. 13).

The lower section of the valley becomes progressively narrower and deeper toward the south. It decreases in width from six miles at Beardstown to a little over two miles at its mouth and increases in depth in the same distance from 250 to over 500 feet. The deepest channel appears to be consistently on the west side of the valley. Glacial deposits partially filling the valley have an average thickness of about 150

[74]Shown from north to south by the Glasford, Peoria, Delavan, Manito, Havana, Rushville, Beardstown, Chandlerville, Petersburg, Arenzville, Meredosia, Griggsville, Pearl, Hardin, Brussels, and St. Charles quadrangle maps.

feet and are similar in composition to those in the lowland above. In its relation to structure the valley lies obliquely across the west limb of the Illinois basin and crosses the Pittsfield-Hadley anticline and the Cap au Grés faulted flexure (fig. 8).

Eastern Tributaries

Tributaries of the Lower Illinois Valley drain northward and westward from the broad upland of central Illinois and, except for short tributaries along the narrow section of valley, they are broad shallow valleys.

Middletown Bedrock Valley.—This valley was probably the largest preglacial tributary. It heads along the north side of the central upland in Moultrie, Shelby, and Christian counties as two main branches which join in eastern Sangamon County. From this point the trunk valley continues northwestward to the Havana Lowland below Middletown in western Logan County (pls. 1 and 2). The position of the valley southeast of Decatur in central Macon County is uncertain, and it is possible that the low rock elevations in central Moultrie County are related to a south tributary of Pesotum Valley rather than to Middletown Valley. South drainage of this section into the Kaskaskia headwaters may have occurred during the glacial period but the prominence of the upland across Shelby County strongly indicates that preglacial drainage led north rather than south. Kansan drift, as well as Illinoian and Wisconsin, has been recognized within the glacial deposits that cover the drainage basin.

Athens Bedrock Valley.[75]—This valley leads northward from a broad head-valley in northwestern Sangamon County to the Havana Lowland in northern Menard County. The position of the valley is established by a wide discontinuity in the bedrock exposures along Sangamon River and by numerous well records. There is a low divide at the head of the valley which could have functioned as a spillway into Arenzville Valley during glacial advances.

Arenzville Bedrock Valley.—Low bedrock elevations east and northeast of Arenzville are interpreted as two branches of a broad buried valley which enters Illinois Valley in southern Cass County. Rock exposures are absent along the Illinois Valley in this area, and more rapid erosion of till bluffs has developed a re-entrant in the valley wall. Except for this feature the valley is buried and there are no physiographic features which indicate its location.

Big Sandy Valley.—Big Sandy Creek occupies a small preglacial valley which enters the Illinois Valley in southern Scott County. The deposits within the valley are of special interest because Nebraskan as well as Kansan and Illinoian tills have been described from an exposure near Winchester.[76]

Apple Creek Valley.—Apple Creek bedrock valley, which enters Illinois Valley in west-central Greene County is unusual in having an expanded central section with narrows above and below. The lower narrows are due to preglacial entrenchment in Mississippian limestones with weak Pennsylvanian shales above; the upper narrow valley has numerous rock exposures and is largely a postglacial feature (pls. 1 and 2).

Macoupin Creek Bedrock Valley.—The preglacial drainage basin of Macoupin Creek was incompletely filled with drift during the Illinoian glaciation. The present drainage system has much the same extent and is largely inherited. The main preglacial valley and south branch is followed by the present stream eastward to the Greene County line above which the course is postglacial, although the old valley is crossed southeast of Carlinville. The preglacial north branch, which occupied the northern part of the drainage basin, coincides in part with the present headwaters of Otter Creek. Most of the present tributaries, however, are independent of preglacial lines. The constriction at the mouth of the valley, as along Apple Creek, is due to the presence of Mississippian limestones (pls. 1 and 2).

[75] Named from the village of Athens, southern Menard County, by Shaw, E. W., and Savage, T. E., U. S. Geol. Survey Geol. Atlas, Tallula-Springfield folio (No. 188), p. 10, 1913.

[76] Bell, A. H., and Leighton, M. M., Nebraskan, Kansan and Illinoian tills near Winchester, Illinois: Bull. Geol. Soc. America, vol. 40, pp. 481-90, 1929.

Western Tributaries

Tributary Valleys North of Spoon River.—Most of the small tributaries north of Spoon River have their courses determined largely by preglacial valleys. A preglacial valley system of considerable size, tributary to Kickapoo bedrock valley, is evidenced by wells and outcrop pattern in southern Peoria County and is now occupied by the middle and upper portions of present Copperas Creek drainage (pls. 1 and 2).

Lower Spoon River Valley.—Spoon River follows the general course of its preglacial valley south from the preglacial divide near the north boundary of Fulton County to the vicinity of Seville where it swings westward and flows through a narrow postglacial valley for a distance of about 12 miles before re-entering the old valley. The buried section of the preglacial valley lies about five miles east of the narrows and passes through the village of Smithfield. Local drillers are familiar with the buried valley and refer to it as the "big drop-off." The narrowing of the lower part of the valley appears to be due to the presence of Mississippian limestones (fig. 7). The structural position of the valley is down the regional dip into the Illinois basin so that the valley could be classed as resequent (fig. 8). Many preglacial tributary valleys were reoccupied after glaciation, whereas others just as large were completely buried and are known only from subsurface data. There are two cols along the divide in western Fulton County by which impounded glacial waters could have entered Carthage bedrock valley.

The glacial deposits within the old drainage basin include: Wisconsin outwash, Illinoian drift of various substages, Kansan till and outwash, and Nebraskan outwash.[77] The presence of Nebraskan gravels in the lower part of the valley system suggests that Nebraskan ice from the Keewatin center probably entered the upper part of the drainage basin.

Sugar Creek Bedrock Valley.—The valley of Sugar Creek crosses the northeastern part of Schuyler County and enters Illinois bedrock valley in the vicinity of Browning. The middle section of the present stream follows the preglacial valley but its upper and lower course is postglacial.

Crooked Creek Bedrock Valley.—The preglacial Crooked Creek valley extended northwestward from Illinois bedrock valley across southern and western Schuyler County and headed in the northwest part of the county. Above this the postglacial system continues for 40 miles almost to the Mississippi bluffs and is largely independent of preglacial drainage lines. In its lower preglacial course the stream crowds the south edge of the old valley and in at least three places is superposed on rock spurs. Unusually low rock elevations and the deep fill along the narrow valley between the lower preglacial course and Carthage Valley suggests trenching across the preglacial divide during the Pleistocene. The valley is eroded completely through the Pennsylvanian strata so that Mississippian limestones are continuously exposed along it (fig. 7).

McGees Creek Bedrock Valley.—A buried preglacial valley extends northwestward across northern Pike County and into southwestern Brown County. The course of the valley is largely independent of present McGees Creek, although the same drainage basin is involved. The lower part of the preglacial valley coincides with Middle Fork but the upper section crosses the main stream at a right angle.

South of McGees Creek to the mouth of Illinois Valley the preglacial tributary valleys were probably small and cannot be readily distinguished from those of recent origin.

ANCIENT IOWA (MIDDLE MISSISSIPPI) SYSTEM

Regional Relations

The Mississippi River below the bend in western Rock Island County, with minor exceptions, follows a large preglacial valley to the mouth of Illinois River. This preglacial valley was independent of the ancient Mississippi and its stream appears to

[77]Wanless, H. R., personal communication.

have headed in southern Minnesota and flowed southeastward across eastern Iowa to Muscatine. The course of this valley and the limits of its drainage basin in Iowa are uncertain, but it is thought to coincide in part with the region now tributary to Iowa River and for this reason the ancient stream has been called the "preglacial Iowa River."[78] A part of this ancient valley system is shown by figures 11 and 20.

Description

The ancient valley is eroded largely in Mississippian limestones and for this reason is relatively narrow and steep-walled. It has an average width of about six miles and is entrenched 250 to 500 feet below surrounding bedrock uplands. The valley is situated structurally along the crest of the broad arch separating the Illinois and Forest City basins so that Meramec-Osage limestones form the bedrock in most places (figs. 7 and 8). North of Henderson County the valley is situated along the trend of the underlying Kinderhook shale, which, together with overlapping Pennsylvanian strata, formed an area of weak rock along which the broad valley south of Muscatine developed. The southern part of the valley in Calhoun County crosses the Lincoln fold and associated Cap au Grés faulted flexure along which the stratigraphic sequence down to the St. Peter sandstone is exposed. South of the flexure the valley again is entrenched in Mississippian limestone for a short distance before turning east to join the ancient Mississippi Valley.

The deposits filling the valley have an average thickness of about 150 feet and, as shown by numerous well records, are composed almost entirely of sand and gravel. The absence of possible Illinoian till in the deposits suggests that at some time following the Illinoian glaciation the valley was re-excavated and that Wisconsin outwash was laid down directly on the rock floor or on older sands and gravels.

Glacial Channels Along the Valley

New Boston Bedrock Channel.—At New Boston in southwestern Mercer County the present Mississippi is superimposed on a buried bedrock island (pl. 1 and fig. 11) which rises over 100 feet above surrounding rock channels. The presence of the island is evidenced by an exposure of Kinderhook shale at the mouth of Edwards River and by wells in the village and across the river in Iowa[79] which encounter rock at shallow depths. It is not clear whether the main preglacial channel was east or west of the island.

Lower Rapids.—The lower rapids of the Mississippi above Keokuk are indicated indirectly on the bedrock surface map of Illinois (pl. 1) by the abrupt valley wall between Hamilton and Nauvoo in Hancock County, but the critical relations are on the Iowa side of the river (fig. 11). Below Fort Madison the river leaves the preglacial valley and follows a narrow Pleistocene channel to the east cut in Mississippian limestones. The buried preglacial course around the rapids is four times wider and more than 100 feet lower than the glacial channel.[80]

The glacial fill in the old valley is of unusual significance as it is believed to be composed mainly of Nebraskan till overlain by thin Kansan drift and loess.[81] This evidence would establish the preglacial age of the valley and indicate that diversion probably occurred during the Nebraskan glaciation, and that by the end of Kansan time the valley was completely buried. Following obstruction of the val-

[78] Leverett, Frank, Outline of the Pleistocene history of the Mississippi Valley: Jour. Geology, vol. 29, p. 617, 1921. More recently Leverett, in Shiftings of the Mississippi River in relation to glaciation: Bull. Geol. Soc. America, vol. 53, p. 1292, 1942, states "more detailed collection and siftings of well records is needed to determine the course of the river and the limits of its drainage basin. A suitable name for it might then be given." The terms, "preglacial Iowa River" and "ancient Iowa system," are retained in the present study purely for convenience, as no new records of wells in Iowa were examined.

[79] Udden, J. A. Geology of Louisa County: Iowa Geol. Survey, vol. 11, pl. 4, p. 96, 1901.

[80] Warren, G. K., Valley of the Minnesota River and of the Mississippi River to the junction of the Ohio: its origin considered; depth to bedrock: U. S. (War Dept.) Chief Eng., Ann. Rept., 1878 (U. S. 45th Cong. 3rd sess.), II. Ex. Doc. 1, pt. 2, App. X, p. 3; Gorden, C. H., Buried river channels in southeastern Iowa: Iowa Geol. Survey, vol. 3, pp. 239-55, 1895; Leverett, Frank, The Illinois glacial lobe: U. S. Geol. Survey, Mon. 38, pp. 467-73, 1899; Old channels of the Mississippi in southeastern Iowa: U. S. Geol. Survey, Annals of Iowa, vol. 5, pp. 38-51, 1901; Shiftings of the Mississippi River in relation to glaciation: Bull. Geol. Soc. America, vol. 53, pp. 1283-98, 1942.

[81] Leverett, Frank, op. cit., p. 1292, 1942.

TABLE 5.—BEDROCK ELEVATIONS ALONG THE ANCIENT IOWA (MIDDLE MISSISSIPPI) VALLEY SYSTEM

Location	Distance, miles	Present ground-surface, feet above sea-level	Bedrock, feet above sea-level	Drift thickness, feet
Cleona channel, western Scott Co., Iowa	0	730	[a]399—	331
T. 77 N., R. 4 W., western Muscatine Co., Iowa	30	638	[b]388—	250+
Muscatine, Iowa (new channel)	7	547	[c]406	141
T. 75 N., R. 3 W., NE Louisa Co., Iowa	8	690	[d]390—	300+
New Boston, sec. 6, T. 13 N., R. 5 W. (Rock Island)	10	530	530	0
Oquawka, sec. 22, T. 11 N., R. 5 W., Henderson Co.	15	530	345	185
Fort Madison	32	520	[c]365—	155
Montclare, Iowa (old channel)	9	679	[c]374	305
Montrose, Iowa (new channel)	—	514	[c]490	24
Keokuk, Iowa (new channel)	12	494	[c]475	19
Quincy, Illinois, sec. 26, T. 2 S., R. 9 W., Adams Co.	40	470	336	134
Kinderhook, Illinois, sec. 35, T. 4 S., R. 7 W., Pike Co.	18	465	335	130
Mouth of Illinois River	75	420	275—	145

[a] Norton, W. H., Geology of Scott County: Iowa Geol. Survey, vol. 9, p. 515, 1899.
[b] Udden, J. A., Geology of Muscatine County: Iowa Geol. Survey, vol. 9, p. 325, 1899. Includes map of bedrock surface.
[c] Leverett, op. cit., Mon. 38, p. 475.
[d] Udden, J. A., Geology of Louisa County: Iowa Geol. Survey, vol. 11, p. 98, 1901. Includes map of bedrock surface.

ley it seems probable, as previously outlined (p. 55), that the ancient Iowa system above the rapids drained eastward from Muscatine into the ancient Mississippi until the Illinoian glacial advance, and that the present course through the lower rapids was not established until after this invasion.

TRIBUTARIES

The present valleys entering the Mississippi from the east have a general parallelism which is strikingly developed throughout most of the drainage basin (pls. 1 and 2). North of Hancock County the uniform westward trend of the valleys is due primarily to ridging of the Illinoian drift and secondarily to control by preglacial valleys. South of Hancock County the persistent southwest trend normal to the main valley was developed largely in preglacial time.

Copperas Creek Valley.—Copperas Creek bedrock valley in southern Rock Island County is only partially filled with Illinoian drift so that the present stream follows the south edge of the preglacial valley in its lower course. The upper section of the present stream has a postglacial valley which is consequent on the Illinoian drift-plain. The essential relations are revealed by the pattern of bedrock exposures (pl. 1).

Edwards River Valley.—This valley was developed between low east-west trending ridges on the Illinoian drift-plain[82] and is essentially unrelated to preglacial drainage lines. Rock exposures are absent in the eastern part of the valley because it crosses the headwater portions of buried preglacial valleys which drained north into Green River bedrock valley.

The gap in rock exposures between Matherville and Cable in northeast Mercer County is apparently due to the presence of a north-south bedrock channel across the course of the stream. This transverse channel is anomalous with preglacial drainage and appears to be a glacial spillway between Green River bedrock valley on the north and the Henderson Creek bedrock valley system on the south.

Pope Creek Valley.—Pope Creek Valley, like Edwards Valley to the north, is largely postglacial. The upper part of the valley is without rock exposures and may represent the headwaters of a bedrock valley draining to the southwest. It is also crossed by the north-south channel noted above in connection with Edwards Valley.

[82]Leverett, op. cit., Mon. 38, pp. 478-79.

Bedrock Valleys along Henderson Creek and its Tributaries.—In the Henderson Creek drainage basin there appear to be three parallel preglacial valleys which head near the crest of the Pennsylvanian upland and coincide in varying degrees with present valleys. In general, however, the pressent drainage is primarily consequent on the Illinoian drift-plain. The northernmost preglacial valley lies directly south of Pope Creek; it is completely buried and is unrelated to present drainage. The second preglacial valley extends westward along the south boundary of Mercer County and is followed for several miles by middle Henderson Creek. The southernmost valley in northern Warren County is a subsequent valley eroded in Kinderhook shale along the margin of the Burlington escarpment; it coincides for a short distance with lower Cedar Creek, but is otherwise independent of present drainage. Just south of the mouth of the valley the present Henderson Creek is superimposed across the northwest corner of the Burlington escarpment, giving rise to the isolated rock headland at Bald Bluff.[83]

Kirkwood Bedrock Valley.—This valley, named from the village of Kirkwood in western Warren County, is completely buried and has no expression in present topography. The valley heads along the central ridge of the Pennsylvanian upland in western Knox County and extends westward across the Meramec-Osage upland, entering the main valley at Oquawka in northern Henderson County. The position of the valley is determined by numerous well records and by the absence of rock exposures. It appears to be about a mile wide in most places and has an average depth of about 100 feet. The few detailed records available indicate that the valley-fill consists largely of till underlain, at least in places, by sand and gravel which rests directly on bedrock. Important thicknesses of sand and gravel are known to be present along the valley near Larchland in central Warren County.

Carthage Bedrock Valley.—The largest tributary of the ancient Iowa River is named from the city of Carthage in central Hancock County. The valley heads within the Pennsylvanian upland in northeastern McDonough County and extends southwestward for 70 miles crossing the Meramec-Osage upland to enter the main valley at the mouth of Bear Creek in the northwest corner of Adams County. An important tributary extends north from Carthage to LaHarpe in the northeast corner of Hancock County. The valley is completely buried below the flat Illinoian drift-plain, except for a restricted area at its mouth, and is unrelated to present drainage. Above Carthage the course of the old valley is closely controlled by well records and the distribution of rock exposures, the latter being a striking feature in McDonough County (pl. 1). Below Carthage the contouring is less exact but the general course is clearly outlined by several well records. The depth of the valley below the bedrock upland increases from less than 100 feet near its head to more than 200 feet along its lower course. The narrows of the valley near the Hancock-McDonough county line is due to the appearance of Mississippian strata along the sides of the valley.

The glacial deposits within the valley are not well known. In southwestern McDonough and eastern Hancock counties, sand and gravel deposits more than 50 feet thick underlie the surficial Illinoian till; north of Carthage in central Hancock County the fill appears to be largely till; and near the mouth of the valley thick sand and gravel deposits are again reported in well records. The presence of older drift underlying the Illinoian has not been established.

The pre-Illinoian drainage history of the valley system was undoubtedly complex, as it lay in the path of both Kansan and Nebraskan glaciers which advanced southeastward from the Keewatin center so that glacial drainage probably was diverted across the divide into the Lower Illinois Valley at several points. It is also possible that Spoon River drainage was diverted westward across the divide by the advance of early Illinoian ice from the northeast.

[83]Keithsburg quadrangle map.

The positions of three possible spillways are indicated by the bedrock-surface map: (1) The sag in northeastern McDonough County between the head of Carthage Valley and Spoon River bedrock valley; (2) a spillway between the same valleys near the center of the east line of McDonough County; and (3) a low point in the divide in the southeastern corner of McDonough County between Carthage Valley and Sugar Creek bedrock valley. A fourth channel of more recent age is indicated by the persistence of low bedrock elevations, less than 450 feet above sea-level, along Crooked Creek which crosses the preglacial divide in southwestern McDonough County.

Mill Creek Bedrock Valley.—Mill Creek bedrock valley heads in east-central Adams County and extends southwestward to enter the Mississippi a few miles below Quincy in the southwestern part of the county. The lower part of the valley is deeply entrenched and coincides closely with the present valley, except near the mouth where the buried preglacial course appears to lie about a mile to the north. The upper buried part of the valley continues eastward from the head of the present stream for a distance of more than ten miles. A possible spillway across the divide to the southeast into McGees Creek bedrock valley is indicated by present topography and rock exposures, although no well records are available in the critical area.

Valleys between Mill Creek and the Mouth of Illinois River.—There are many short steep bedrock valleys which head along the crest of the bedrock upland and extend southwestward to enter the Mississippi Valley at essentially right angles. Most of the larger valleys are probably preglacial, although the extent of later modification is undetermined.

One of the larger of these valleys, that of upper Bay Creek in Pike County, was thought to have formerly drained southeastward into the Illinois Valley and to have been deflected by Illinoian ice into its present course.[84] This possibility is weakened by numerous bedrock exposures now known to be present along the middle section of the valley which indicate uniformly high bedrock. It is more probable that the entire valley is largely preglacial.

A glacial drainage channel south of Batchtown in Calhoun County (pl. 1) is related to the Kansan ice-sheet which apparently entered the Mississippi Valley to the west.[85]

LOWER MISSISSIPPI VALLEY

Physiographic and Structural Relations

Below the mouth of the Illinois River the present Mississippi turns eastward and then southward, and for a short distance in the vicinity of St. Louis flows in a broad valley across a western embayment of the Pennsylvanian lowland. A few miles below St. Louis the valley narrows, and for more than 100 miles the river occupies a rock trough incised across the eastern flank of the Ozark Plateaus. The discordance with structure is emphasized by the fact that within this distance the valley, from north to south: (1) Crosses the Meramec-Osage ridge in northern Monroe and southern St. Clair counties; (2) turns southward for a short distance in central Monroe County along the western margin of the Meramec-Osage escarpment following the strike of upper Ordovician strata; (3) swings southeastward and recrosses the escarpment in southern Monroe and western Randolph counties; (4) cuts against the northwest end of the Pennsylvanian escarpment and parallels a narrow fault zone in southern Randolph and Jackson counties; and (5) turns southward across an upfaulted segment of the Salem Plateau in Union and Alexander counties (figs. 7 and 8). In central Alexander County the valley finally enters the Mississippi embayment of the Coastal Plain and widens into the broad valley at the southern tip of the State.[86]

[84]Leverett, op. cit., Mon. 38, pp. 480-81.

[85]Rubey, W. W., Geology and mineral resources of the Hardin-Brussels quadrangles: U. S. Geol. Survey, unpublished manuscript, pp. 401-02, 1931. The physiographic relations are shown on the Hardin and Brussels quadrangle maps.

[86]The anomolous course of the river was described as follows by E. W. Shaw, Quarternary deformation in southern Illinois and southeastern Missouri (abs.): Bull. Geol. Soc. America, vol. 26, p. 68, 1915: "The position of the Mississippi River shows lack of adjustment, for it flows

In addition to crossing the structurally controlled ridges developed on the eastern flank of the Ozark structural dome, it has been proposed that peneplain remnants in southeastern Missouri form a surface that has been warped into a topographic dome, along the east slope of which the valley is likewise entrenched.[87] This possible relation and others will be discussed in a later connection (pp. 97, 98).

Description

The bedrock valley of the Mississippi in this area is a well-defined trench, similar in most respects to the Middle Mississippi and Lower Illinois bedrock valleys (pl. 1). In the Pennsylvanian Lowland of the St. Louis region the width of the valley is a little more than ten miles but this decreases to an average of about five miles along the channel through the Ozark Plateaus. Upon emerging from the plateaus in central Alexander County the valley enters the broad Mississippi alluvial plain which at Cairo is more than 50 miles wide.

The trough-shape of the valley is shown by the bedrock profiles in figure 14 which are based on closely spaced test-holes drilled by the U. S. Army Corps of Engineers. The profiles reveal an undulatory rock floor with one or more deeper channels. A rock bench, 40 to 50 feet above the deep channel, is shown in cross-section A-A′ and is the only feature suggesting that entrenchment may have been accomplished in more than one cycle of erosion. The bedrock floor of the valley slopes southward at an average rate of about seven inches per mile from an elevation of about 260 feet above sea-level at St. Louis to less than 164 feet above sea-level at Cairo (table 4). Bedrock uplands adjoining the valley rise 200 feet above the rock floor of the valley in the St. Louis region and over 500 feet in the plateaus to the south. The maximum relief of the bedrock surface in the vicinity of the valley is found in northern Union County where Bald Knob rises about 785 feet above the rock floor of the valley.

From the scattered borings available it appears that the deposits in this section of the valley, like those above, are composed largely of sand and gravel with minor amounts of clay and silt. Boulders, some up to 10 inches in diameter, are reported from depths slightly over 100 feet in several records of wells and from bridge pier excavations in the East St. Louis region.

Two deflections of the river from its preglacial course occur within this section of the valley; both are south of the glacial boundary. At Fountain Bluff in southwestern Jackson County the present narrow channel has isolated a rock spur from the west bluff. The broad preglacial valley to the east has been kept open and is still occupied during flood stages. The second deflection is farther downstream at Thebes in central Alexander County where for a distance of about six miles the river occupies a narrow gorge entrenched across a spur which projects westward into Missouri. It is believed that both drainage changes could have been caused by alluviation of the valley to the level of low points across the spurs.[88]

Tributaries

Cahokia Creek Bedrock Valley.—The preglacial drainage system is represented by three branches which head in southern Macoupin County and join a few miles above Edwardsville to form the main bedrock valley (pls. 1 and 2) which enters the Mississippi in central Madison County. The present stream follows a preglacial valley in its lower course but the upper course, although confined by the preglacial drainage basin, is unrelated in detail to the preglacial valleys which are buried by drift.

Marys River Valley.—The bedrock valley of Marys River, located just east of the lower Kaskaskia Valley, originates in the

on the side of a trough, both structural and physiographic. The natural place for the river between St. Louis and Cairo is in the low, soft-rock country 50 miles or more east of its present position."

[87]Flint, R. F., Ozark segment of Mississippi River; Jour. Geology, vol. 49, pp. 626-40, 1941.

[88]Leverett, op. cit., Mon. 38, p. 474.

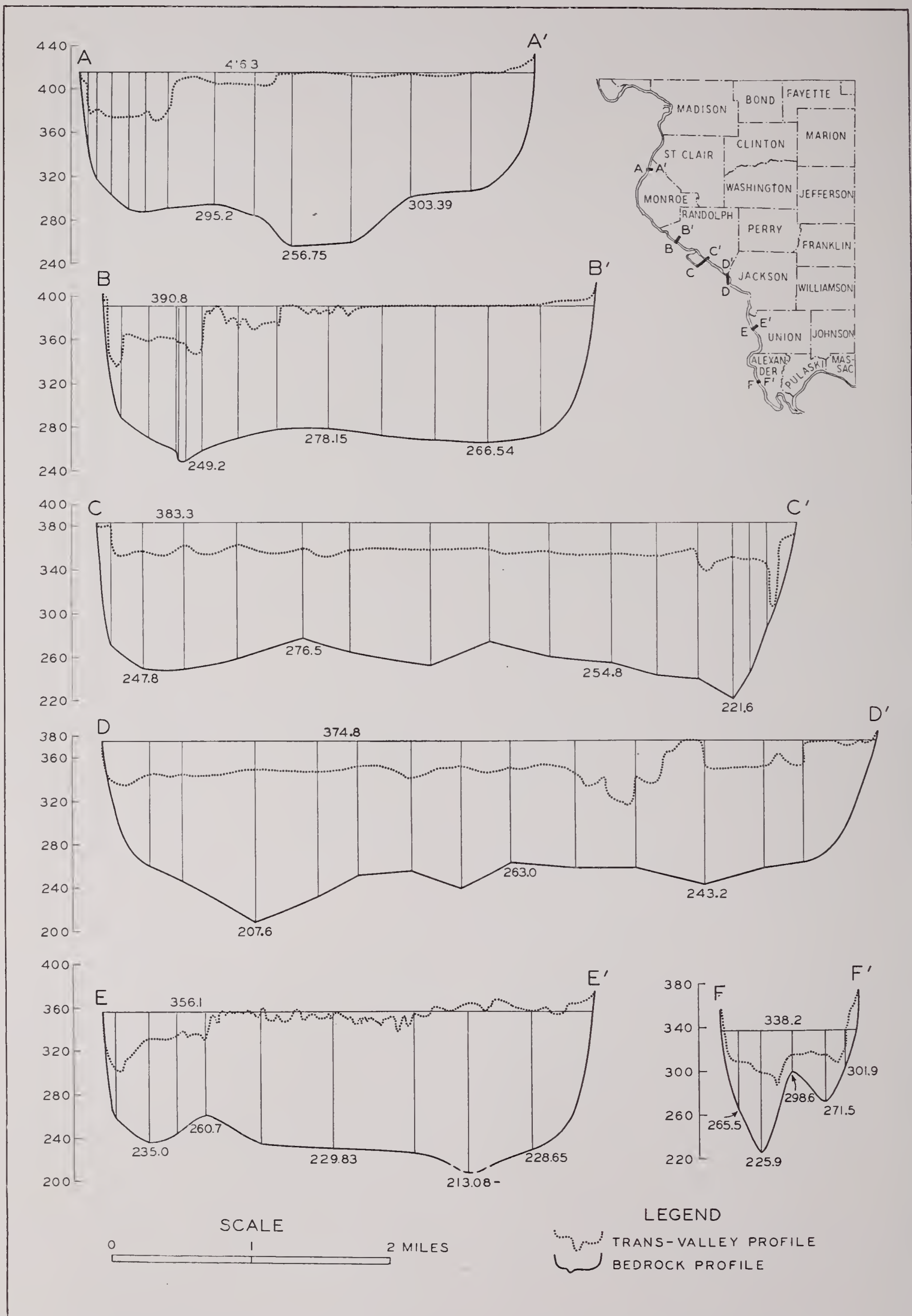

Fig. 14.—Bedrock profiles along lower Mississippi Valley. Based on borings by Corps of Engineers, U. S. Army.

Pennsylvanian lowland in eastern Randolph County and extends southward across the Pennsylvanian escarpment to enter the Mississippi just below Chester (pls. 1 and 2). The drainage basin is crossed by an Illinoian moraine which extends southeastward across the county (fig. 9) and appears to have buried the main branch of the preglacial valley which extended southward from Sparta in the northwest part of the county. The present stream heads within this buried drainage basin east of Sparta but within a short distance crosses a preglacial divide near Rosboro and continues south along an east branch of the preglacial system. This interpretation, based on limited data, is tentative and needs to be verified by additional studies.

Big Muddy Drainage Basin.—The large Big Muddy drainage basin covers about 2400 square miles in the Pennsylvanian Lowland lying immediately north of the Shawnee Hills. The drainage system is asymmetrical with the major tributaries lying north of the trunk stream. Like Marys and Kaskaskia rivers to the north, the stream crosses the ridge margining the Illinois basin in a constricted valley below Murphysboro, Jackson County, and the great fan of tributaries above the narrows is a reflection of this structural relation.

The drainage basin as a whole is covered by thin Illinoian drift which does not conceal the bedrock upland topography, although the lowlands are deeply alluviated by post-Illinoian lacustrine and fluvial deposits.[89] There is no evidence of important drainage modifications. The low divide between Crab Orchard Creek and South Fork Saline River in southern Williamson County may have functioned as a temporary spillway during the Illinoian ice advance but there appears to have been no important bedrock erosion. Illinoian spillways at much higher elevations are known to have led across the Pennsylvanian escarpment to the south.[90]

[89]Shaw, E. W., Newly discovered beds of extinct lakes in southern and western Illinois and adjacent states: Illinois Geol. Survey Bull. 20, pp. 139-157, 1915.
[90]Lamar, J. E., Geology and mineral resources of the Carbondale quadrangle: Illinois Geol. Survey Bull. 48, pp. 149-51, 1925.
Grogan, R. M., personal communication.

KASKASKIA VALLEY

Physiographic and Structural Relations

The great elongate bedrock basin occupied by the middle and lower Kaskaskia River extends northeastward from the Mississippi in Randolph County for a distance of 130 miles into central Shelby County. The present drainage basin is somewhat larger and continues for 50 miles northward on the Wisconsin drift-plain into central Champaign County.

The most striking physiographic feature of the drainage basin is due to the fact that in the lower ten miles of its course the trunk stream leaves the broad basin-like valley in the Pennsylvanian Lowland and crosses the Meramec-Osage cuesta in a narrow valley not more than a mile in width. This relation has resulted in the accession of an abnormal number of tributaries by the trunk stream and provided a local baselevel so that a series of broad bedrock valleys forming the Kaskaskia lowland was developed in the Pennsylvanian Lowland above the barrier of Mississippian rocks. The bedrock valley system is asymmetrical with larger tributaries on the north. Essentially the entire drainage basin lies within the Illinoian drift-sheet (fig. 9).

Description of the Main Valley

The main bedrock valley rapidly expands above the lower narrows into a broad bedrock lowland which is almost ten miles wide in St. Clair County and maintains a width of about five miles north as far as southern Shelby County. Throughout this distance the valley is shallow, the central channel being only 100 to 156 feet below the bedrock uplands. The estimated average gradient of the rock floor of the valley below Shelby County, based on the elevations shown in table 6, is 14 inches per mile which is about twice that of the Lower Mississippi Valley.

Below the northeast bend in southern Clinton County the present river closely

Table 6.—Bedrock Elevations along Kaskaskia Valley

Location	Distance, miles	Present ground-surface, feet above sea-level	Bedrock, feet above sea-level	Drift thickness, feet
Sec. 7, T. 10 N., R. 4 E., southern Shelby Co.	0	583	483	100
Sec. 34, T. 9 N., R. 2 E., northern Fayette Co.	14	545	365	180
Sec. 31, T. 4 N., R. 1 W., southern Fayette Co.	35	440	340	100
Sec. 17, T. 1 N., R. 2 W., southern Clinton Co.	16	460	328−	132+
Sec. 13, T. 1 N., R. 5 W., western Clinton Co.	15	418	270	148
Sec. 5, T. 3 S., R. 7 W., southern St. Clair Co.	22	418	288	130
Sec. 23, T. 6 S., R. 8 W., mouth of valley, Randolph Co.	21	390	[a]236.7	153.3

[a] Corps of Engineers, U. S. Army, 1908.

follows the preglacial valley, but above this point the valley is partially concealed by drift and the stream in most places lies a short distance west of the bedrock channel. In northern Fayette County the preglacial valley is abandoned and the stream above occupies a postglacial valley to the east. Above the Shelbyville moraine in central Shelby County the course is consequent on the Wisconsin drift and is entirely independent of the bedrock topography. It crosses the preglacial divide between the Kaskaskia and the Mahomet drainage basins and extends for about 50 miles beyond.

The deposits filling the bedrock valley are not well known but appear to consist of thin Illinoian and possibly older drift overlain by thick post-Illinoian fluvial and lacustrine deposits. The latter reach thicknesses of 100 feet and are composed of sand, silt, and clay with minor amounts of gravel.

Tributaries

The present tributaries are a complex of both preglacial and postglacial valleys with the headwaters and secondary tributaries generally postglacial and the larger valleys following preglacial courses. Only three of the larger valleys are described, as in most cases the relations are clearly shown by the bedrock-surface map (pl. 1) and by the quadrangle maps.

Silver Creek Bedrock Valley.—The Silver Creek Valley forms a broad northern embayment of the Kaskaskia lowland in eastern St. Clair County which is followed by the present stream. North of St. Clair County the course is postglacial and its headwaters are within the preglacial Cahokia Creek drainage basin. Near the mouth of the valley the present stream is superimposed on the west slope of the valley so that rock is exposed along the stream southeast of Freeburg.

Shoal Creek Bedrock Valley.—The partly buried preglacial drainage basin of Shoal Creek heads in central Montgomery County and extends south to the main valley in western Clinton County. Although the present stream follows the general axis of the preglacial lowland, in detail there is no more than coincidental parallelism between the preglacial and recent channel. The relations are most clearly brought out by examining plate 1.

Sandoval Bedrock Valley.—The only important tributary valley completely buried by drift is the Sandoval bedrock valley. It heads in central Marion County and passes northward and westward through Sandoval to enter the main valley in southeastern Clinton County. Rock exposures are absent within this area and numerous records show that bedrock is abnormally low.

WABASH DRAINAGE BASIN

Physiographic and Structural Relations

The present Wabash drainage basin in Illinois covers roughly the eastern third of the southern half of the State. It is considerably larger than the preglacial drainage basin which terminated a short distance north of the Shelbyville moraine in Coles

and Edgar counties (pl. 2). For a distance of 80 miles north from the moraine the drainage is consequent on the Wisconsin drift-sheet and is for the most part unrelated to preglacial topography. The entire valley system to the south is on the Illinoian drift-sheet.

The preglacial drainage basin lies entirely within the Pennsylvanian Lowland where weak bedrock permitted development of broad shallow valleys which to the south coalesce to form the Wabash Lowland district. The valley is transverse in relation to structure and from north to south crosses the southern part of the LaSalle uplift and the deep part of the Illinois basin (fig. 8).

All of the large valleys are drowned with thick fluvial and lacustrian deposits which form broad flat lowlands above which outliers of the uplands rise as "island hills"[91] or lie buried below the alluvium. These aggraded lowlands and associated landforms are the outstanding physiographic feature of the area. They are more prominently developed along the Wabash than along the Mississippi, primarily because of the more subdued preglacial topography in the Wabash drainage basin. There is little difference in the total thickness of the valley-fill.

Description of the Main Valley

Because the valley is aggraded, the present river departs widely from the bedrock channel and in places is superimposed across upland spurs, abandoning the old channel altogether (pl. 1). Thus the central portion of the preglacial valley in some places lies in Illinois and in other places in Indiana. In passing from north to south the physiographic relations of the old channel are as follows: (1) North of Lawrence County the bedrock channel in most places is on the Indiana side; (2) in central Lawrence County the channel swings into Illinois and the present river is superimposed on a spur of the Indiana upland; (3) from southern Lawrence County to northern White County the old channel lies to the east and the present river is crowded against and locally superimposed on the Illinois upland; (4) in White County and nearly to the mouth of the valley the old channel is in Illinois and the river is superimposed on the east valley wall.

The valley has an average width of about five miles and is eroded 150 to 250 feet below surrounding uplands. The average gradient, estimated from the bedrock elevations shown in table 7, is about nine inches per mile as compared with seven inches per mile for the lower Mississippi bedrock valley in Illinois.

The deposits filling the valley in most places are 100 to 150 feet thick and are composed of sand, gravel, silt, and clay in about that order of abundance. The bulk of the deposits appears to be alluvium and Wisconsin outwash and associated lacustrine deposits.

Tributaries

Saline Valley System.—The Saline drainage basin lies directly north of the Pennsylvanian escarpment and covers all of Saline County and adjoining parts of Gallatin, White, Hamilton, and Williamson counties. It is included in the Wabash system because the preglacial outlet appears to have been directly east into the Wabash Valley rather than southeast through the narrower valleys which lead to the Ohio.

The entire valley system is within the Pennsylvanian Lowland except for short minor tributaries which drain the north slope of the Pennsylvanian cuesta. The glacial boundary follows the general course of South Fork so that most of the area is within the Illinoian drift-sheet. The drift, however, formed only a thin mantle on the uplands and caused no important changes in the preglacial drainage.

The three main branches, South Fork, Middle Fork, and Rector Creek, are broad and shallow and, together with the lower Little Wabash Valley, form the Wabash lowland subdivision of the Pennsylvanian Lowland (fig. 6). Aggraded lowlands extend into headwater sections of the valleys. Along the South Fork the fill is essentially continuous across the divide to the west into Crab Orchard Creek Valley at the head of the Big Muddy drainage basin.

[91]Term proposed by Shaw, op. cit., p. 159.

Table 7.—Bedrock Elevations along Wabash Valley

Location	Distance, miles	Present ground-surface, feet above sea-level	Bedrock, feet above sea-level	Drift thickness, feet
Sec. 24, T. 7 N., R. 11 W., central Crawford Co.	21	435	308	127
Sec. 30, T. 4 N., R. 10 W., central Lawrence Co.	22	425	310	115
Sec. 6, T. 1 N., R. 11 W., northeastern Wabash Co.	15	410	310	100
Sec. 23, T. 3 S., R. 14 W., southern Wabash Co.	25	363	253	110
Sec. 9, T. 5 S., R 14 W., central White Co.	10	359	245	114
Sec. 19, T. 7 S., R. 11 E., southern White Co.	15	357	238	119
Sec. 22, T. 8 S., R. 10 E., mouth of valley, Gallatin Co.	6	361	221	140

Little Wabash Drainage Basin.—The present Little Wabash and its major tributary, Skillet Fork, occupy an ovate preglacial drainage basin which extends north-northwest from White County for almost 100 miles. The present drainage heads only ten miles or so north of the preglacial basin so that there is closer correspondence between the present and preglacial systems than there is in the adjoining Kaskaskia and Embarrass valleys.

The drainage system lies entirely within the Pennsylvanian lowland and, although it slopes southeastward down dip toward the center of the Illinois structural basin in northern White County, it has a dendritic pattern and shows no other evidence of structural control. The area is covered with Illinoian drift, which south of southern Clay County is too thin to obscure bedrock features, but to the north thickens so that a flat drift-plain was formed. As a result of this difference in drift thickness, the present drainage south of southern Clay County closely follows preglacial valleys while that to the north departs widely from them (pl. 1). An important exception in the southern part of the valley occurs where a thick post-Illinoian fill forms a broad aggradational lowland, and the present stream is superimposed on the west upland in White County and enters the Wabash about 12 miles below the mouth of the preglacial channel.

Bonpas Creek Valley.—The Bonpas Creek Valley heads in southeastern Richland County and extends southward along the Edwards-Wabash county line to the Wabash Valley near Grayville. The Illinoian drift in the drainage area is thin so that there is essentially no difference between the present and preglacial drainage basins. The valley-fill is about 100 feet thick at the mouth of the valley and thins northward.

A possible glacial spillway across the divide to the west into Little Wabash Valley is indicated by the break in the ridge between Bone Gap and Albion, T. 1 S., R. 10 E., Edwards County (pl. 1).

Embarrass Valley.—The present Embarrass River originates south of the Champaign moraine in central Champaign County and flows southward across the Wisconsin drift-plain to Charleston in central Coles County where it crosses the Shelbyville moraine and enters an older interglacial valley[92] eroded in the Illinoian drift-plain (fig. 15). The older valley, eroded during the Sangamon interglacial stage, is followed southward to southwestern Crawford County where the river enters the still older preglacial valley which is followed to the Wabash. The present drainage basin extends northward 60 miles beyond the limits of the preglacial basin. In the Illinoian drift-covered area the two drainage basins coincide closely, although the main preglacial channel is buried except for a short distance above its mouth in Lawrence County (pl. 2).

The preglacial valley is relatively broad and shallow, ranging in width from one to five miles and in depth from 100 to 200 feet. A single important tributary enters the main valley in western Crawford County.

[92]Hubbard, G. D., An interglacial valley in Illinois: Jour. Geology, vol. 12, pp. 152-160,1904.

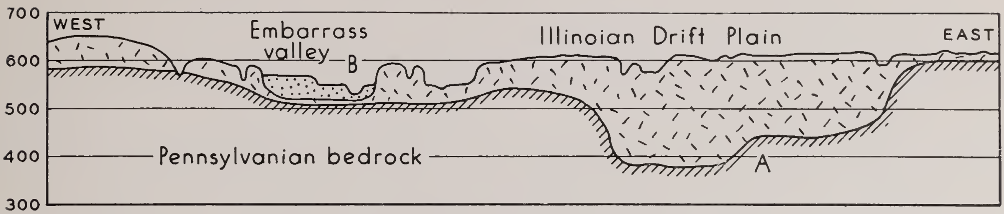

FIG. 15.—Preglacial, interglacial (Sangamon) and postglacial valleys of the Embarrass River in northern Cumberland County. Cross-section extends from section 4, T. 10 N., R. 9 E. eastward to section 18, T. 10 N., R. 14 W. A—preglacial valley filled with Illinoian and older (?) drift; B—Sangamon Valley filled with Wisconsin (Shelbyville) outwash and recent valley eroded in the outwash.

The glacial deposits filling the valley probably include pre-Illinoian as well as Illinoian drift, since pre-Illinoian till is exposed at the surface a few miles west of the valley in northern Cumberland County (sec. 10, T. 10 N., R. 9 E.).[93] Important thicknesses of sand and gravel are known to be present within the valley in a few places but their areal extent is not known.

The tributary valleys north of the Embarrass head along the preglacial divide in central Edgar and Clark counties and descend rapidly southeastward to the Wabash (pl. 1).

CACHE VALLEY AND OHIO RIVER VALLEY

Below the mouth of the Wabash, the present Ohio bedrock valley extends southwestward across the Pennsylvanian escarpment and the low plateaus of the Shawnee Hills section past Cache Valley, thence southward across the Cretaceous upland of the Coastal Plain, and westward along the approximate contact between Cretaceous and Tertiary beds to the Mississippi at Cairo. Cache bedrock valley, which crosses the state 10 to 20 miles north of the Ohio, lies along the northern margin of the Coastal Plain and closely follows the contact between Mississippian and overlying Cretaceous strata. The two valleys are so intimately related physiographically that it is convenient to consider them together.[94]

CACHE VALLEY

The large Cache bedrock valley represents an abandoned course of the Ohio River and is one of the most impressive physiographic features in the State. It has an average width of about three miles and is entrenched 250 to 400 feet below the crests of surrounding bedrock uplands. The eastern part of the valley is occupied by Big Bay Creek and the western part by Cache River. Both streams are underfit in that they occupy a valley much larger than could have been eroded by either stream. The unoccupied section of the valley between the two streams in northwestern Massac County is low and swampy so that the entire valley is subject to flooding during exceptionally high flood stages of the Ohio.

The north valley-walls are eroded in Paleozoic rocks and are more abrupt and continuous than those on the south which are eroded in weaker Cretaceous beds. Trimming back of the north valley-wall by lateral plantation is evidenced by asymmetrical cliffed hills and spurs in which erosion in some places has cut back as far as the central ridge.[95] These normal valley features are not to be confused with other linear cliffs which are clearly controlled by faulting. A striking fault-line scarp forms the northwest valley wall in T. 14 S., R. 4 E., northern Massac County (pl. 1).[96]

The deposits filling the valley have a maximum thickness of 140 to 180 feet and are composed largely of glacial sand and gravel. Much of the fill is certainly Wis-

[93]MacClintock, Paul, Recent discoveries of pre-Illinoian drift in southern Illinois: Illinois Geol. Survey Rept. Inv. 19, p. 41, 1929.

[94]Present physiographic relations are clearly displayed by the Shawneetown, Fords Ferry, Golconda, Brownfield, Vienna, Dongola, Jonesboro, Thebes, Cairo, LaCenter, Paducah, and Smithland quadrangle maps, Illinois and Kentucky. The bedrock surface below an elevation of 350 feet above sea-level along the two valleys (but not the upland topography) is shown on plate 1.

[95]A good example near Forman in southern Johnson County (secs. 32 and 33, T. 13 S., R. 3 E.) is shown on the Vienna quadrangle map.

[96]Shown on the Vienna and Brownfield quadrangle maps.

consin in age but older outwash material also may be present.

Ohio River Valley

The bedrock valley across the Coastal Plain south of Cache Valley, now occupied by Ohio River, is narrower and apparently somewhat shallower than Cache bedrock valley. The average width of the bedrock valley excluding the broad bottomland at the bend of the river in southern Massac and Pope counties, is a little over two miles and the depth is 150 to 200 feet below bedrock uplands on the north. Bedrock elevations along the channel, as determined from the study of well cuttings, appear to be more than 250 feet above sea-level, which is 50 feet or more above the floor of Cache Valley. The valley is asymmetrical with steeper valley walls on the Cretaceous beds to the north than on the Tertiary plain to the south. Two important tributary valleys, the Cumberland and Tennessee, enter the main valley at the bend in southern Massac and Pope counties.

The Ohio valley across the Shawnee Hills to the north in most places is not more than a mile wide and is entrenched 150 to 350 feet below immediate bedrock uplands.

Drainage History

The preglacial ancester of the present lower Ohio appears to have been a drainage system which headed near the east border of Indiana and included the lower Wabash Valley on the north, Green River Valley on the south, and a middle fork along the present course of the Ohio (fig. 20). Below the mouth of the Wabash this drainage followed the Ohio Valley southwestward to southern Pope County where it turned westward through Cache Valley and thence southward to the ancient Mississippi in southeastern Missouri or northeastern Arkansas. South of this drainage line the preglacial Cumberland and Tennessee rivers united in southeastern Massac County and flowed westward along the present Ohio Valley to join the ancient Wabash-Ohio system west of Cairo.[97]

During the glacial period, probably as the result of Kansan glaciation from the Labradorean center, the ancient Teays (Mahomet) system was obliterated and the present Ohio system was inaugurated. This was followed by aggradation of the valleys during the Illinoian and Wisconsin glacial stages so that some time during the process, probably during the Illinoian,[98] the flood plain was raised to the level of the divide between the Cumberland and Ohio rivers at Bay City in southern Pope County and the present lower course of the Ohio was opened. Both courses were kept open during subsequent stages of valley excavation and glacial flooding so that it has only been in recent time that the southern channel has been lowered slightly and established as the permanent course.

[97]J. Marvin Weller, *in* Geology and oil possibilities of extreme southern Illinois: Illinois Geol. Survey Rept. Inv. 71, p. 47, 1940, suggests that the ancient Cumberland River may have flowed northward into the ancestral Ohio rather than southward into the Tennessee.

[98]Leverett, Frank, op. cit., Mon. 38, p. 528.

CHAPTER 5—EROSIONAL HISTORY

MESOZOIC AND EARLY CENOZOIC HISTORY

Throughout most of Illinois the long time lapse between the end of the Pennsylvanian and the completion of the oldest erosion surfaces in the late Tertiary is not recorded either by sediments or erosion surfaces, and the major events which transpired can be inferred from geologic relations only in neighboring regions.

With the disappearance of the Pennsylvanian seas the Upper Mississippi Valley region became dominantly a land area and has remained so ever since. During the ensuing Permian period the area probably remained close to sea-level, but with the mountain-building movements which marked the close of that period and the Paleozoic era, the area was uplifted and the bedrock formations were deformed into essentially their present structural positions. This important event doubtless initiated the earliest drainage systems in the region, and it is not improbable that an ancestral Teays river flowed westward from the newly formed Appalachians across the interior of the continent throughout most of the Mesozoic era which followed. Whether this stream discharged southward across a sag in the Appalachian ranges in the present gulf embayment region or continued westward to the sedimentary basins of the Rocky Mountain region is uncertain. During late Cretaceous and Eocene times the gulf embayment was clearly in existence and receiving sediments, and provided a logical outlet for interior drainage. To the west the ranges of the Rocky Mountains were being formed during this same interval and may have blocked an outlet in that direction.

The western half of the Mississippi drainage basin was outlined by the building of the Rockies, and during the late Pliocene or preglacial Pleistocene time, parallel east-flowing streams were established on the great detrital aprons extending from the mountains across the Great Plains. At this time the upper Missouri probably flowed north into Hudson Bay, and the Niobrara, Platte, and Kansas rivers discharged southward into the gulf by way of the Lower Mississippi Valley (fig. 20, p. 98). The earliest erosion surfaces in Illinois are believed to have been formed during the later stages of aggradation in the Great Plains, that is, during the later part of the Tertiary period.

UPLAND SURFACES

Basis of Interpretation

Ever since the concept of baselevel was first clearly set forth by American geologists during the later half of the last century there has been a tendency to interpret landforms in terms of cycles of erosion. In accordance with this principle it is possible for an uplifted land mass to be eroded down to a surface of low relief determined ultimately by the level of the sea. The lowest level to which an area can be eroded is termed *baselevel* and the series of changes through which the land surface passes during the process is called the *cycle of erosion.* The *initial stage* of the cycle is represented by an uneroded original land-surface from which the cycle proceeds through the stages of youth, maturity, and old age.

Youthful landscapes are characterized by incomplete stream dissection so that remnants of the initial surface remain on the inter-stream areas. *Youthful valleys,* which are narrow, steep-walled and without flood-plains, predominate. The *mature* stage is reached when all traces of the initial surface are gone and the region is completely in slopes. *Mature valleys,* marked by flood-plains, are present along larger streams, although tributaries remain youthful. The final stage of *old age* is reached when the baselevel condition is approached and a surface of low relief, or *peneplain,* extends over

Table 8—Summary of Physiographic History

Geologic Time	Deposition and Weathering	Erosion	Drainage
Recent	Alluvium	Minor valleys	Present systems
Wisconsin	Mankato valley-train		Present systems
	Cary drift		Essentially present systems
	Tazewell drift		Burial of Ticona Valley and establishment of present Upper Illinois Diversion of Mississippi to present course
	Iowan valley-train		Ancient Mississippi—upper Iowa system
Sangamon	Late Sangamon loess Soil formation and weathering	Valleys	Rock River system Ticona Lower Iowa Ohio
Illinoian	Labradorean drift		Temporary Mississippi through Lake Calvin in Iowa; burial of Pawpaw and Troy valleys and inauguration of present Rock River
Yarmouth	Soil formation and weathering	Valleys	Upper Iowa—ancient Mississippi Ancient Rock Ticona Lower Iowa Ohio
Kansan	Keewatin and Labradorean drift		Destruction of Mahomet (Teays) system and establishment of the present Ohio and Ticona systems ?Diversion of upper Iowa into ancient Mississippi
Aftonian	Soil formation and weathering	Valleys	Mahomet Upper Iowa—ancient Mississippi Ancient Rock and Troy rivers Lower Iowa Ancient Wabash
Nebraskan	Keewatin and Labradorean drift		?Diversion of upper Iowa into ancient Mississippi ?Adoption of Pekin-Sankoty channel at Peoria
Preglacial Pleistocene (?)	Weathering	Valley entrenchment Havana strath	Mahomet (Teays) Ancient Mississippi Ancient Rock and Troy Ancient Iowa Ancient Wabash
Late Tertiary	"Lafayette" gravel	Central Illinois peneplain Lancaster-Calhoun-Ozark peneplain Dodgeville-Buzzard's Point (?) peneplain	Drainage problematical

wide areas. The cycle may be interrupted at any stage and a new cycle initiated, so that in cases where the later cycles are of shorter duration than earlier ones, two or more erosion surfaces belonging to different cycles may be preserved. The length of

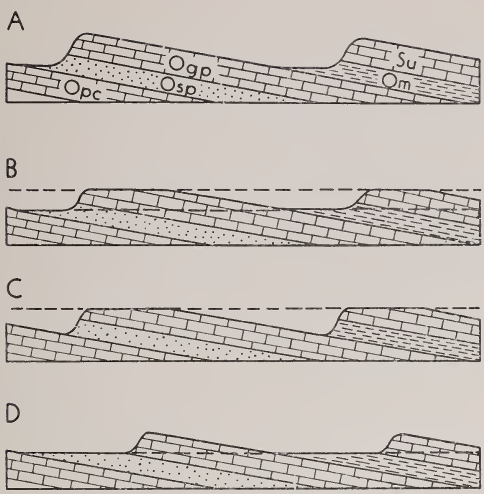

FIG. 16.—Alternative interpretations of upland surfaces in the Driftless Area. Su—Silurian dolomite; Om—Maquoketa shale; Ogp—Galena-Platteville dolomite; Osp—St. Peter sandstone; Opc—Prairie du Chien dolomite.

A. Cuestas developed by noncyclical erosion (Martin).
B. Two peneplains (Trowbridge).
C. One peneplain developed on higher parts of the upland (Bates).
D. One peneplain developed on lower parts of the upland (Thwaites).

time required for the cycle is variable, depending on structure, intensity of erosion, and the amount of initial relief.

Remnants of uplifted peneplains and younger cyclical surfaces were recognized at an early date in the Appalachian region, and for the past 50 years attempts have been made to refer bedrock surfaces in the Mississippi Valley to Appalachian cycles. In contrast to the concept of cyclical erosion is the view that the bedrock surface was produced by continuous down-cutting since the close of the Paleozoic era and that differences in relief are due primarily to structure. According to this viewpoint erosion was non-cyclical.

The existence of cyclical surfaces in the interior has been difficult to establish because of the cover of glacial drift in most places and the nearly horizontal attitude of bedrock formations over large areas so that it is difficult to distinguish cyclical surfaces from structural plains developed on resistant formations. Yet there are certain features of the bedrock surface which strongly indicate that three or more cyclical levels are present in Illinois. These features, which are described below, include: (1) Rock surfaces which truncate structures at uniform elevations; (2) rock surfaces on different resistant beds which rise to uniform elevations in spite of the fact that greatly different thicknesses of rock were removed from above; (3) abrupt breaks in upland profiles which cannot be related to structures; (4) preglacial river gravels on upland surfaces; and (5) major bedrock valleys which lie transverse to structure. Whether these evidences are convincing or not, it is reasonable to assume that the State passed through more than one cycle of erosion in the 250 million odd years since it rose from the sea. Any other assumption would imply crustal and climatic stability as well as resistance to erosion that would be out of keeping with other regions where the record is more definitely established.

Upland Surfaces in the Driftless Areas

It is natural that the earliest studies of erosion surfaces in the State were made in the driftless areas where the factor of drift thickness did not have to be considered and where the relief is strongly marked. With these areas as a basis, an attempt will be made to decipher the geomorphic relations in the drift-covered area where the evidence is much less complete.

NORTHWESTERN ILLINOIS

The upland surfaces in the Driftless Area of the Upper Mississippi Valley have been intensively studied for the past 50 years[1] and as yet there is no general agree-

[1]Hershey, O. H., Preglacial erosion cycles in northwestern Illinois: Am. Geologist, vol. 18, pp. 72-100, 1896; The physiographic development of the Upper Mississippi Valley: Am. Geologist, vol. 20, pp. 246-68, 1897; Grant, U. S. and Burchard, E. F., Description of the Lancaster and Mineral Point quadrangles: U. S. Geol. Survey Geol. Atlas, folio 145, pp. 1-14, 1907; Trowbridge, A. C., Some partly dissected plains in Jo Daviess County, Illinois: Jour. Geology, vol. 21, pp. 731-42, 1913; Shaw, E. W. and Trowbridge, A. C., Description of the Galena and Elizabeth quadrangles, U. S. Geol. Survey Geol. Atlas, folio 200, pp. 1-13, 1916; Trowbridge, A. C. and Shaw, E. W., Geology and Geography of the Galena and Elizabeth quadrangles: Ill. Geol. Survey Bull. 26, pp. 136-46, 1916; Hughes, U. B., A correlation of the peneplains of the Driftless Area: Proc. Iowa Acad. Sci., vol. 23, pp. 125-32, 1916; Trowbridge, A. C., The erosional history of the Driftless Area: Univ. Iowa Studies, 1st ser., no. 40, Studies in Nat. Hist. vol. 9, pp. 55-127, 1921, is

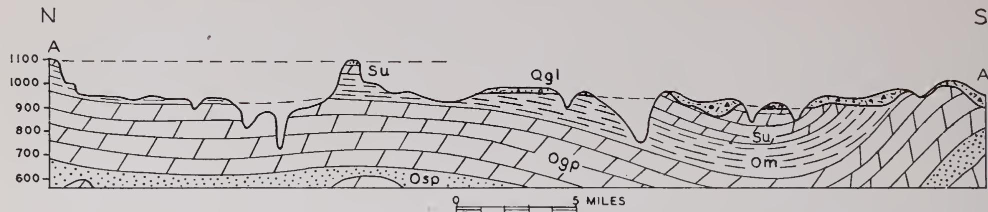

FIG. 17.—Cross-section showing Dodgeville (upper) and Lancaster (lower) surfaces in northwestern Illinois along A-A′ of figure 18. Qgl—glacial drift; Su—Silurian dolomite; Om—Maquoketa shale; Ogp—Galena-Platteville dolomite; Osp—St. Peter sandstone.

ment on the number of surfaces present or their age. Interpretations have ranged from the development of the features in one cycle[2] to the other extreme in which five cyclical surfaces were identified.[3] Most students of the region have recognized remnants of either one or two peneplains. Alternative interpretations of upland histories are shown diagramatically in figure 16.

In the Illinois section of the Driftless Area two prominent upland surfaces are present (fig. 17). The upper surface, which has been termed the Dodgeville peneplain,[4] is represented by the tops of isolated mounds or ridges capped by Silurian dolomite which range in elevation from 1,150 to 1,000 feet above sea-level and lie 450 to 350 feet above drainage. The lower surface, usually called the Lancaster peneplain,[5] lies about 150 feet below the Dodgeville plain and is more extensively developed than the older surface. It coincides closely with the top of the Galena dolomite and slopes southward from 1,000 to 900 feet above sea-level.[6] There appear to be no additional cyclical surfaces between the Lancaster and the rock floor of the Mississippi Valley.

Upland gravels belonging to the Windrow formation are found on remnants of the Dodgeville peneplain in adjoining states[7] but only scattered pebbles occurring at various elevations have been found in Illinois. Nebraskan drift is reported to be present on both upland surfaces in Iowa but not in valleys eroded below the Lancaster plain, which has led Trowbridge[8] to conclude that the lower surface was undissected at the time of Nebraskan glaciation.

CALHOUN COUNTY, WESTERN ILLINOIS[9]

The surface of the narrow central upland in Calhoun County, 700 to 750 feet above sea-level, has been described as the Calhoun peneplain, and an intermediate level 125 to 250 feet lower has been identified as a post-mature surface. Gravels of "Lafayette-type," composed of chert, quartz, and quartzite in ferruginous matrix, are present on the upper surface north of the Cap au Grés faulted flexure and on a lower surface about 600 feet above sea-level south of the flexure in the southern tip of the county (fig. 18 and pl. 1). This relation raises the question of whether the gravels were deposited at different levels on two distinct surfaces or whether there was important movement along the Cap au Grés fault since their deposition. The upland surface both north and south of the struc-

the most detailed study of the entire problem and contains complete bibliography up to 1921; Martin, Lawrence, Physical geography of Wisconsin: Wis. Geol. and Nat. Hist. Survey Bull. 36, second edition, pp. 69-77, 1932; Trowbridge, A. C., Kansan Geological Society guide book, 9th annual field conference, upper Mississippi valley, pp. 62, 75, 1935; Thwaites, F. T., Road log for fourth day, Idem., pp. 105-26, 1935; Bates, R. E. Geomorphic history of the Kickapoo region, Wisconsin: Bull. Geol. Soc. America, vol. 50, pp. 820-41, 1939, is a detailed recent study.

[2] Martin, op. cit., pp. 69-77, 1932.

[3] Hershey, op. cit., pp. 72-100, 1896.

[4] Named from the upland near Dodgeville, Wisconsin by A. C. Trowbridge, op. cit., p. 64, 1921; Professor Trowbridge now believes that this plain is part of the lower Lancaster peneplain and not an independent surface, personal communication, 1946.

[5] Named from Lancaster, Wisconsin, by Grant, U. S. and Burchard, E. F., op. cit., p. 7, 1907.

[6] Both surfaces are shown on the Galena and Elizabeth quadrangle maps. The Lancaster surface in the vicinity of Apple River canyon in the Elizabeth quadrangle is particularly striking.

[7] Salisbury, R. D., Preglacial gravels on the quartzite range near Baraboo, Wisconsin: Jour. Geology, vol. 3, pp. 655-67, 1895; Trowbridge, A. C., op. cit., pp. 111-13, 1921; Thwaites, F. T. and Twenhofel, W. H., Windrow formation; an upland gravel formation of the Driftless and adjacent areas of the upper Mississippi valley: Bull. Geol. Soc. America, vol. 32, pp. 293-314, 1920.

[8] Op. cit., pp. 62, 75, 1935; pp. 123-25, 1921.

[9] Based largely on studies by W. W. Rubey, unpublished manuscript, 1931. The gravels are described in: Salisbury, R. D., On the northward and eastward extension of the pre-Pleistocene gravels of the Mississippi Basin: Bull. Geol. Soc. America, vol. 3, pp. 183-186, 1892; Weller, Stuart, Notes on the geology of northern Calhoun County: Ill. Geol. Survey Bull. 4, p. 231, 1907.

Table 9.—Erosion Surfaces in Southern Illinois

Hardin County (Salisbury)		Williamson, Jackson, and Union Counties (Lamar, Carbondale quadrangle)	
Name	Elev.	Elev.	Location
Present floodplains	320–340	320–350	Carbondale quadrangle
Elizabethtown plain	400–420		
McFarlan plain	500–540	500–560	Carbondale quadrangle
Karbers Ridge plain	600–640	600–650	Carbondale quadrangle
		700–760	Carbondale, Alto Pass, Jonesboro and Murphysboro quadrangles
Buzzard's Point plain	860–900	800–860	Carbondale quadrangle

ture is developed largely on Osage limestones with that to the north clearly transgressing structures.

SOUTHERN ILLINOIS

The diversity of land forms in Southern Illinois, as emphasized by its subdivision into three major physiographic provinces, is reflected in the upland surfaces which are limited in extent and occur at several levels on various bedrock formations. Since no detailed studies of the entire problem have been made, conclusions must be based on studies of two local areas and on broad regional relations. As the result of studies in Hardin County in the eastern part of the area and in the Carbondale quadrangle in the western part, four upland surfaces ranging in elevation from 500 to 900 feet have been recognized, as shown by table 9.[10] In more general studies the summits of the upland, 700 to 800 feet above sea-level, along the Pennsylvanian escarpment and on the Salem Plateau have been considered to be at or close below the level of a widespread erosion surface that is possibly correlative with the Ozark peneplain in Missouri, the Highland Rim (Lexington) surface in Kentucky, and the Lancaster peneplain in northwestern Illinois.[11] The surface is believed to transect Wilcox (Eocene) strata and was therefore probably completed some time during the Tertiary.[12]

In reviewing the problem an attempt was made to reconstruct the bedrock surface as it may have existed prior to the period of preglacial valley entrenchment, by projecting contours across the recent valleys (fig. 18). The restoration suggests that there is a widespread upland surface about 700 feet above sea-level which is probably correlative with the 700 to 760-foot surface in the Carbondale quadrangle (table 9) and with the Ozark and Calhoun peneplains. Higher sections of the upland rising to the level of the Buzzards Point plain and above to elevations of about 1000 in Hardin, Pope, and Union counties may represent remnants of an older surface or monadnocks on the lower surface. It is significant that the Devonian formations of the Salem Plateau have been weathered and leached to a depth of about 400 feet, and that this unusual depth of alteration has been ascribed to a prolonged period of alteration under peneplain conditions.[13]

Below the summit surface there is a pronounced break in upland profiles to a lower surface on the south, 500 to 550 feet above sea-level (fig. 18). This surface is developed on Chester strata north of Cache Valley and appears to continue onto Cretaceous beds south of the valley. It may be correlative with the McFarlan plain in Hardin County. The intermediate Karbers Ridge plain, 600 to 650 feet above sea-level, may be present on the Meramec limestones in southeastern Union County as well as in Hardin County. Whether these lower surfaces represent local or regional base-levels or are largely the products of dif-

[10] Weller, Stuart, Butts, Charles, Currier, L. W. and Salisbury, R. D., Geology of Hardin County: Ill. Geol. Survey Bull. 41, pp. 47-52, 1920; Lamar, J. E., Geology and mineral resources of the Carbondale quadrangle: Ill. Geol. Survey Bull. 48, pp. 152-54, 1925.

[11] Fenneman, N. M.: Physiography of eastern United States, pp. 441, 504, New York, 1938; Flint, R. F., Ozark segment of Mississippi River: Jour. Geol., vol. 49, pp. 626-40, 1941.

[12] Flint, R. F., op. cit., pp. 639-40.

[13] Weller, J. M., Devonian system in southern Illinois: Illinois Geol. Survey Bull. 68A, Devonian Symposium, pp. 101-02, 1944.

ferential erosion are questions on which further evidence is needed.

"Lafayette-type" gravel occurs on the Salem Plateau in Union County, on the Pennsylvanian escarpment in Gallatin County,[14] on the crests of hills and ridges representing the McFarlan (?) plain, and at lower elevations toward the Ohio Valley (fig. 18). In places a weathered layer up to about six feet thick is present on the "Lafayette," or more locally on the McNairy (Cretaceous), and below the loess. These relations indicate that the deposition of the "Lafayette" gravels was followed by a long period of stable conditions under which weathering progressed, and that the major period of erosion ending with essentially the present bedrock surface occurred during the final part of the post-Lafayette-preglacial interval.[15]

Upland Surfaces in the Drift-covered Areas

Except in the southern part of the State where the Illinoian drift is thin and the preglacial uplands are clearly reflected in the present landsurface, interpretations of the upland and lower surfaces are based on subsurface data compiled in the form of the bedrock-surface map (pl. 1) and the theoretical map of the landsurface as it existed prior to the entrenchment of the deep valleys (fig. 18). The latter map is the main basis of reference in following sections.

GALENA UPLAND SURFACE

Description.—The Galena upland surface forms a single broad and remarkably uniform plain which slopes southeastward from 950 feet above sea-level in northern Stephenson County to 800 feet in central DeKalb County (figs. 18 and 19). The gradient is about three feet per mile. Local relief on the restored surface in most places is less than 50 feet and reaches a maximum of about 100 feet in northeastern Carroll County. The broad low upland crest which crosses central Ogle County and forms the divide between the preglacial Mississippi and Rock River drainage basins may be either the cause or result of drainage development.

Along the south and east margins of the upland there is a break in the upland profiles between elevations of 800 feet on the north to elevations of 650 feet on the south within a distance of about 20 miles (fig. 18). The zone along which the change occurs is independent of structure, and along it is drawn the boundary between the Galena upland surface and the central Illinois peneplain.

Relation to Structure.—The upland surface is developed largely on the Galena dolomite, although only in a few places does it coincide closely with the upper part of the formation. A comparison of the bedrock contours (pl. 1 and fig. 18) with the structure contours on the top of the formation (fig. 19) shows that in the western half of the upland the rock surface is generally 150 feet or more below the top of the dolomite, and that to the east the surface crosses onto the Maquoketa shale and lies 100 feet or more above the top of the Galena formation. In more local areas the surface is developed on beds ranging in age from the Niagaran (Silurian) dolomite to the Trempealeau (Cambrian) dolomite.

When the structure trends are compared with topographic trends on the bedrock surface, a further lack of coincidence is revealed. The regional slope of the upland surface is roughly S. 30°E., whereas the two major structure trends are about N-S for the Wisconsin arch and N. 60°W. for the positive element between the Sandwich fault zone and the LaSalle monocline (figs. 8 and 19). In specific areas there are several places where truncation of structure can be established: (1) Across the Savanna-Sabula anticline and the syncline to the north in northwestern Ogle and northern Carroll counties (fig. 17); (2) across the southwest flank of LaSalle monocline in southwestern Ogle County; (3) across the Sandwich fault zone and related structures in southeastern Ogle and northeastern Lee counties; and (4) across

[14] Butts, Charles, Geology and mineral resources of the Equality-Shawneetown area: Illinois Geol. Survey Bull. 47, p. 52, 1925.

[15] Weller, J. M., Geology and oil possibilities of extreme southern Illinois: Illinois Geol. Survey Rept. Inv. 71, p. 45, 1940.

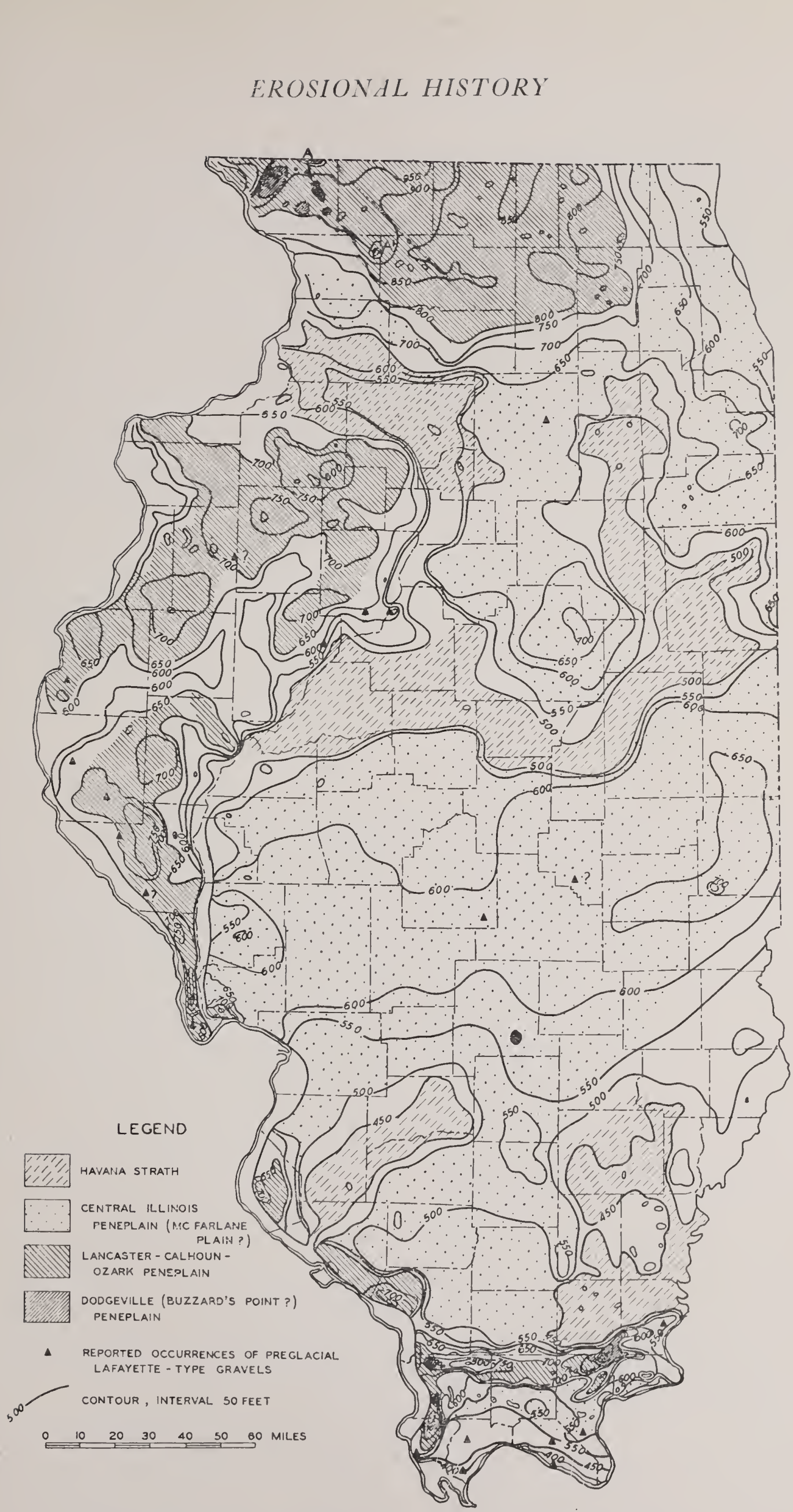

FIG. 18.—Generalized contour map of the erosion surfaces in Illinois.

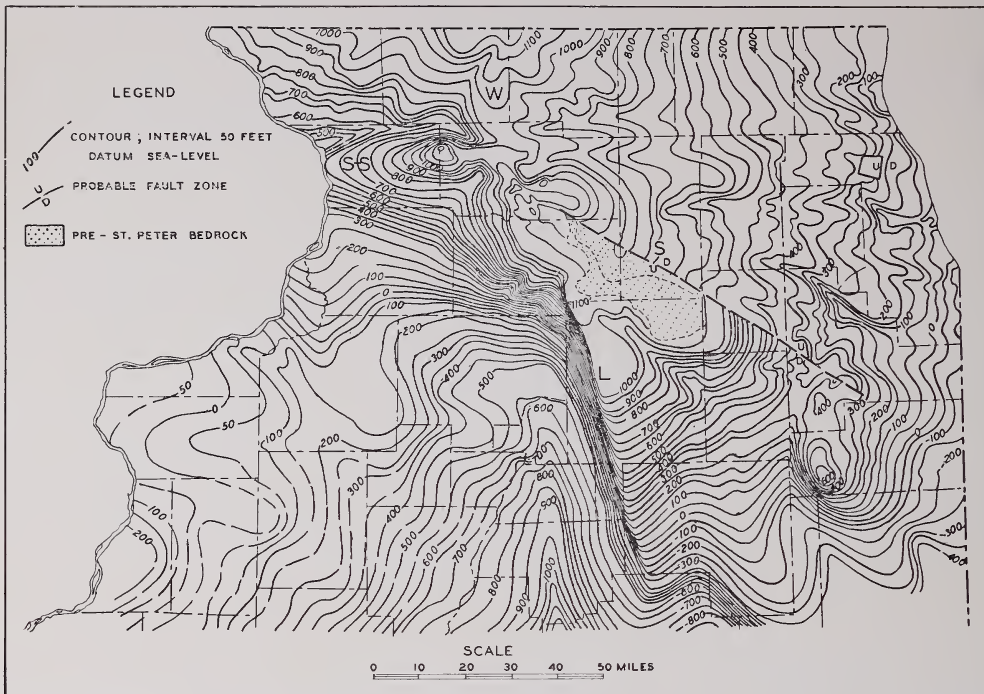

FIG. 19.—Structure contours on top of the Galena dolomite in northern Illinois. W—Wisconsin arch; S-S—Savanna-Sabula anticline; S—Sandwich fault zone; L—LaSalle anticlinal.

numerous minor folds which plunge down regional dip on the east flank of the Wisconsin arch.

It is concluded that there is only a gross relation between structure and the upland surface and that in detail the transgressions of structure are so numerous and important that the surface cannot be regarded as a structure plain.

Interpretation and Correlation.—The Galena upland surface has been previously recognized within the area and interpreted as remnants of what is now generally regarded as the Lancaster or late Tertiary peneplain.[16] This conclusion is substantiated by the present study. The alternative that the surface represents the higher Dodgeville peneplain of the Driftless Area is possible only if downwarping is postulated. There is no evidence of warping, and the upland profiles indicate continuity with the lower Lancaster surface.

A possible lower surface 100 to 180 feet below the upland has been noted in Stephenson, Winnebago, and Ogle counties.[17] This surface, if present, is not extensive enough to be revealed as a regional feature on the bedrock-surface map (pl. 1), possibly because of the large 50-foot contour interval.

UPLAND SURFACES IN WESTERN ILLINOIS

Description.—The bedrock uplands in western Illinois are discontinuous and so varied in elevations that it is not possible to refer them to a single upland surface, as can be done for the Galena Upland to the north and the Pennsylvanian Lowland to the east. Instead the reconstructed upland surface (fig. 18) appears to be a broad mature surface of relatively low relief on which there are possible remnants of a summit surface 700 to 800 feet above sea-level, now largely destroyed, and of a poorly

[16]Hershey, O. H., Preglacial erosion cycles in northwestern Illinois: Am. Geologist, vol. 18, pp. 72-100, 1896; The physiographic development of the upper Mississippi valley: Am. Geologist, vol. 20, pp. 246-68, 1897; Bretz, J H., Geology and mineral resources of the Kings quadrangle: Illinois Geol. Survey Bull. 43, pp. 273-77, 1923; Knappen, R. S., Geology and mineral resources of the Dixon quadrangle: Illinois Geol. Survey Bull. 49, pp. 90-93, 1926.

[17]Hershey, O. H., op. cit.
Bretz, J H., op. cit.

developed lower surface 600 to 650 feet above sea-level. The upper surface is interrupted by the Carthage and Spoon River preglacial drainage basins so that it is not continuous from north to south. To the north it is most extensively developed in Mercer, Henry, and Knox counties and to the south in Adams and Pike counties. Possible remnants of the lower surface occur along the north margin of the upland and in southern Fulton and western Tazewell counties.

The fact that the higher surface continues from the weak Pennsylvanian beds onto the Meramec-Osage dolomites without important changes in elevation indicates that the surface is largely independent of structure. Actually the highest summits are on Pennsylvanian strata in Knox and Henry counties. There is a general lack of adjustment between the surfaces and local structures. This may be seen by comparing figures 18 and 8.

Preglacial gravels of "Lafayette-type" have been reported from Pike, Adams, Hancock, Fulton, Peoria, Tazewell, Warren, Henderson, and possibly Rock Island counties[18] (fig. 18).

Interpretation and Correlation.—The Calhoun peneplain is continuous with the summit surface as far north as Adams and Brown counties and may continue across Carthage Valley to the upland surface on the north. If the surface is projected still further north across the Green River Lowland, a correlation between the Calhoun and Lancaster peneplains appears possible. Even though actual remnants of the old surface may be absent in the intervening area, much of the upland is close to the required level.

[18]Worthen, A. H., Geology of Hancock County: Geol. Survey of Ill., vol. I, p. 330, 1866; Geology of Pike County: Geol. Survey of Ill., vol. IV, p. 37, 1870; Geology of Fulton County: Idem. p. 91; Bannister, H. M., Geology of Tazewell, McLean, Logan and Menard Counties: Idem, p. 179.

Occurrences in Adams, Henderson, and possibly Rock Island counties are reported by Salisbury, R. D., A further note on the ages of the orange sands: Am. Jour. Sci., vol. 42, 3d ser., pp. 252-3, 1891; On the northward and eastward extension of the pre-Pleistocene gravels of the Mississippi Basin: Bull. Geol. Soc. America, vol. 3, pp. 183-86, 1892.

The occurrence in Peoria County was noted by Udden, J. A., The geology and mineral resources of the Peoria quadrangle: U. S. Geol. Survey Bull. 506, p. 50, 1912, and possible occurrences in southern Pike and eastern Warren counties were reported by J. E. Lamar, personal communication.

The lower surface, if present, is a westward continuation of the extensive erosion surface in the Pennsylvanian Lowland.

CENTRAL ILLINOIS PENEPLAIN

Description.—The erosion surface in central Illinois is believed to extend over the entire Pennsylvanian Lowland and to be widely developed on the Niagara cuesta of northeastern Illinois. It is thus the most extensive erosion level found within the State. Many of its features have been noted (pp. 35-37).

The surface is remarkably uniform in elevation. Throughout the northern three-fourths of the area, upland elevations in most places lie between the 600- and 650-foot contours; to the south they descend to about 500 feet (fig. 18). The highest sections of the upland occur as broad rises 650 to more than 700 feet above sea-level along the Niagara escarpment and in McLean and Edgar counties. The most extensive remnants of the surface occur along the watershed south of Mahomet Valley, along the divide between Kempton Valley and the ancient Mississippi Valley, and along the Niagara cuesta. Remnants of the surface may be present in the Pennsylvanian Upland to the west, as previously noted, and also on the Niagara cuesta of northwestern Illinois north of the Green River Lowland.

Three possible occurrences of preglacial gravel in the Central Lowland have been reported. One is based on specimens from a diamond-drill boring on the upland at Pana, Christian County (fig. 18), where a thin bed of ferruginous conglomerate with angular and rounded chert pebbles rests on limestone at the base of the drift.[19] The other occurrence, near Wedron in LaSalle County (fig. 18), has recently been described.[20] The deposit occurs on a relatively flat bedrock surface at an elevation of 540 to 550 feet or about 50 feet below the highest part of the upland and consists of 2 to 4 feet of limonitic conglomerate and sandstone with dark brown polished chert pebbles.

[19]Leverett, Frank, The Illinois glacial lobe: U. S. Geol. Survey Mon. 38, p. 107, 1899.

[20]Willman, H. B., and Payne, J. N., Geology and mineral resources of the Marseilles, Ottawa, and Streator quadrangles: Illinois Geol. Survey Bull. 66, pp. 140-41, 1942.

A third possible occurrence is represented by sample cuttings (examined by the writer) of a deposit at the base of the drift penetrated by a well south of Sullivan in central Moultrie County which is about 30 miles northeast of the Pana locality. The deposit consists of 15 feet of ferruginous conglomerate with quartz and chert pebbles mixed with weathered Pennsylvanian siltstone similar to the underlying bedrock. It occurs within upper Middletown bedrock valley at an elevation of about 485 feet rather than on the upland and may represent local reworking of a more extensive upland gravel.

Relation to Structure.—There is a general coincidence of the surface with the Illinois basin but a general lack of adjustment to local structure (figs. 18 and 8). Truncation of structure is apparent along the entire length of the LaSalle uplift between LaSalle and Lawrence counties. It is noteworthy that the McLean and Edgar county uplands lie respectively on the west and east flanks of the structure. In the LaSalle region beds ranging in age from Pennsylvanian to Prairie du Chien (Ordovician) are transected by the surface. The lack of adjustment is also well shown by the extension of the surface from the Pennsylvanian lowland onto the Niagara cuesta without important changes in elevation.

Interpretation and Correlation.—The surface is believed to be a single peneplain developed largely on the weak rocks of the Illinois basin below the level of older surfaces to the north, west, and south. The surface has been recognized in various parts of southern Illinois[21] and in most cases ascribed to a "third cycle" of erosion completed in the Tertiary and following the two cycles that are represented by uplands in the driftless areas of southern and northwestern Illinois.[22] In the northern part of the area the surface has been clearly identified in LaSalle County and correlated with the Galena upland surface and Dodgeville peneplain.[23] This correlation is not supported by the bedrock-surface map compiled in the present study, which indicates physiographic discontinuity between the local surface and the Galena Upland surface and that the latter is continuous with the lower Lancaster peneplain rather than with the Dodgeville.

POSSIBLE STRATHS ALONG MAJOR DRAINAGE LINES

Strath terraces showing a broad valley or incipient peneplain stage preceding stream entrenchment appear to be present along the preglacial Mahomet, ancient Mississippi, Kaskaskia, and Wabash drainage systems, and possibly along Carthage Valley of the ancient Iowa system (fig. 18). As the existence of these surfaces is based entirely on subsurface data, they are related only indirectly to the alluvial plains which floor some of these valleys at present.

As previously noted in connection with the description of the major valleys, the cyclical significance of some of the surfaces is uncertain because local baselevels and glacial drainage changes may have been important factors in their development. This is especially true of the Green River Lowland. In other places the bedrock surface cannot be clearly delineated because of lack of control. It is significant, however, that the terraces occur at elevations which seem to descend regularly from 550 feet at the north to 450 feet and less at the south and that the valleys are clearly wider than those which resulted from late preglacial or glacial entrenchment. Because of these features the surface is interpreted as an erosion level intermediate between the central Illinois peneplain and the "deep valley stage" and is termed the Havana strath, so named from the Havana bedrock-lowland in Mason and adjoining counties.

[21] Shaw, E. W. and Savage, T. E., U. S. Geol. Survey Geol. Atlas, Murphysboro-Herrin folio (No. 185), p. 12, 1912; Shaw, E. W. and Savage, T. E., U. S. Geol. Survey Geol. Atlas, Tallula-Springfield folio (No. 188), p. 10, 1913; Shaw, E. W., U. S. Geol. Survey Geol. Atlas, New Athens-Okawville folio (No. 213), p. 8, 1921; Shaw, E. W., U. S. Geol. Survey Geol. Atlas, Carlyle-Centralia folio (No. 216), p. 7, 1923; Lee, Wallace, U. S. Geol. Survey Atlas, Gillespie-Mt. Olive folio (No. 220), p. 1, 1926.

[22] This is the conclusion of E. W. Shaw, op. cit. Wallace Lee, op. cit., pp. 1, 11, correlated the surface with the lower (Lancaster) surface in the Driftless Area and suggested its possible completion in the Mesozoic and uplift in the Tertiary.

[23] Willman, H. B. and Payne, J. N., Geology and mineral resources of the Marseilles, Ottawa, and Streator quadrangles: Illinois Geol. Survey Bull. 66, pp. 204-5, 1942.

ENTRENCHED PREGLACIAL VALLEYS

The valleys which were described in detail in the previous chapter are entrenched 100 feet and more below the Havana strath and represent the final episode in preglacial erosional history. Although the preglacial age of the upper Mississippi Valley has been questioned, there is evidence that Nebraskan drift is present in valleys of the ancient Mississippi, Mahomet (Teays), and Iowa systems[24] indicating that these valleys, and probably most of the deep valleys in the State, were eroded to their present levels before the glacial period.

PREGLACIAL EROSIONAL HISTORY

The earliest event of which there is physical record is evidenced by the Dodgeville peneplain in the Driftless Area. This surface probably was completed sometime during the later half of the Tertiary and extended for an unknown distance southward. A similar surface, the Buzzard's Point plain, may have been present in southern Illinois, although the evidence for this surface is much less convincing. This cycle of erosion was terminated by rejuvenation of drainage so that the sluggish streams on the old age surface were quickened and began degradation toward a lower baselevel. The cause of rejuvenation is obscure. It could have resulted from regional uplift or downwarping or from important climatic or drainage changes.

The surface developed during the second cycle of erosion is more widely preserved but originally was less extensive than the Dodgeville. It is represented by the Lancaster peneplain in northern Illinois, the Calhoun peneplain in western Illinois, and the Ozark peneplain in southern Illinois. Remnants of the surface are fairly continuous along the western edge of the State and it is not improbable that the peneplain once extended over much of the Pennsylvanian Lowland.

The position of drainage lines during this and the preceding cycle are speculative. There is some evidence suggesting that by the close of the second cycle the ancestral Mississippi was flowing across the east flank of the Ozark dome and that this course was maintained during the warping of the Ozark peneplain which followed.[25] If this hypothesis is adopted it is possible that the ancestral Mississippi, together with other major preglacial streams, was inherited from drainage lines on the Ozark-Calhoun-Lancaster surface. From what is known of Tertiary physiography and late preglacial drainage lines, it is logical to assume that there was a convergence of drainage lines toward the Pennsylvanian Lowland and thence to the head of the gulf embayment. In accordance with this plan the ancestral Teays entered the lowland from the east, the ancient Mississippi from highlands to the north, and the ancient Iowa and ancestral Missouri systems entered the Lower Mississippi Valley from the Great Plains area being built up to the west (fig. 20).

Most of the streams on the old landsurface were probably insequent. Other types may have been present locally as consequent streams in areas of recent aggradation and as subsequent and resequent streams in unreduced areas of hard rock. The Lower Mississippi and Ozark drainage could well have been of the latter type with a radial pattern of resequent streams on the Ozark dome and the ancestral Mississippi following a subsequent valley on the east flank of the structure. With warping of the Ozark peneplain an antecedent valley was established along this section of the Mississippi which came to be the trunk valley for the preglacial drainage of most of the Interior Lowland.

Following completion of the peneplain, and possibly prior to the third cycle represented by the central Illinois peneplain, "Lafayette-type" gravels were deposited on the upland in western Illinois.[26]

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[24]See pages 70, 75.

[25]Flint, R. F., Ozark segment of Mississippi River: Jour. Geology, vol. 49, pp. 626-40, 1941.

[26]These gravels present numerous unsolved problems. Their age is indefinite and it is probable that deposits of various ages are represented in the Upper Mississippi Valley as well as in the Gulf states. The general similarity of the deposits could be explained by redeposition at various times of an originally widespread deposit or by repeated

FIG. 20.—Possible preglacial drainage systems in central United States. Based on studies by Alden, Fidler, Frye, Greene, Horberg, Lamb, Lane, Leverett, Reed, Spencer, Stout, Tight, Todd, Ver Steeg and others.

During the third cycle of erosion a local peneplain was eroded largely on the weak beds of the Illinois basin. The extent of this surface to the east and northeast is not known, but to the north and west it terminates against remnants of higher surfaces and could hardly have extended for any distance in that direction. Ancestors of the major preglacial streams probably were present in the area, although their courses undoubtedly shifted repeatedly and did not become established until rejuvenation toward the close of the cycle. A local surface, the McFarlan plain (?), may have been developed in the Shawnee Hills at this time, although the common occurrence of "Lafayette" gravel in this area and its absence on the central Illinois peneplain to the north, except for three possible localities, suggests that its history may have been somewhat different.[27]

During the Havana cycle the main preglacial drainage lines were established and broad valleys were eroded along the Mahomet, ancient Mississippi, Kaskaskia, Wabash, and possibly the ancient Iowa systems. A sharp rejuvenation of drainage closed the cycle and initiated the "deep valley" stage. This probably occurred at a time near the close of the Pliocene and opening of the Pleistocene when important earth movements were bringing about widespread changes in the physical environment throughout the continent. The direct causes may have been vertical uplift, a change in elevation of sea-level, or climatic changes, or combinations of the three. In any event the streams rapidly entrenched themselves, and by the time of the Nebraskan glaciation had developed important valley systems.

The major preglacial valleys recognized in Illinois were trunk valleys through which most of the drainage of the interior of the continent converged and entered the gulf

access to similar source materials. The preglacial gravels on the Calhoun and Ozark peneplains may well be older than similar deposits occurring at lower elevations in the Shawnee Hills and elsewhere. If the gravels are considered essentially contemporaneous, important deformation of the peneplain and its gravel cover is indicated by differences in elevations of the deposits.

[27]If the surfaces are correlative, the gravels must be considered younger than those occurring on the Calhoun and Ozark peneplains; if all the gravels are correlative, the McFarlan plain (?) could be considered a downwarped segment of the Ozark peneplain.

embayment. Most of the valleys are thus regionally significant, and in figure 20 an attempt is made to reconstruct the major stream systems. The map is a compilation based on numerous previous studies[28] and is regarded only as a tentative interpretation of the scattered data available. There appear to have been three master drainage systems: (1) The St. Lawrence system drained the preglacial valleys probably present along the axes of the present Great Lakes; (2) the upper Missouri system, including the preglacial James and Red rivers, drained both of the Dakotas, as well as the Missouri Plateau to the west, and probably discharged northward into Hudson Bay; and (3) the Mississippi system, considerably smaller than at present, included the Lower Missouri with its greater tributaries, the Platte and Kansas, the ancient Iowa, possibly including the Niobrara, the ancient Upper Mississippi, the Teays, and the Ohio.

These ancient drainage systems were dismembered by the continental glaciers which moved down from the north during the Pleistocene, and in many places their valleys were buried by glacial debris. It is surprising indeed that so many valleys survived and are active drainageways at the present time.

PLEISTOCENE DRAINAGE HISTORY

The complex sequence of drainage events accompanying advances and retreats of the various ice-sheets and the drainage systems of the interglacial stages are known only in part. In a few restricted areas fairly detailed histories have been worked out, but for the State as a whole the Pleistocene drainage history hangs largely by a few established events of major importance and upon the geographic relations of the bedrock valleys and drift-sheets. Most of the events summarized at this point were noted in the preceding chapter and are outlined in table 8 and figure 21.[29]

Pre-Illinoian

The earliest ice-sheet to enter the State was the Nebraskan which pushed across the ancient Iowa River from the west and probably covered a large part of the upland of western Illinois (fig. 21). During this advance the headwaters of the Iowa above the lower rapids of the present Mississippi at Keokuk were probably diverted eastward past Rock Island into the ancient Mississippi, establishing a course which may have been maintained until Wisconsin time. Nebraskan ice may also have crossed the Middle Illinois bedrock valley into Scott County, but there is no evidence that there was other than a temporary deflection of the ancient Mississippi at that point. Except for the modification of the ancient Iowa, drainage in Illinois during the following Aftonian interglacial was much the same as in preglacial time.

The effects of the succeeding Kansan glaciation were more far-reaching. Glaciers advanced both from the northeast (Labradorean center) and the west (Keewatin), probably in that order, and together covered the greater part of the State (fig. 21). As the result of the advance from the northeast, Mahomet Valley and its important north tributary, Newark Valley, appear to have been largely filled with drift, and the present Ohio and glacial Ticona systems were inaugurated. There is as yet no evidence of important drainage changes during the succeeding Yarmouth interglacial stage.

[28]The following publications were particularly helpful: Alden, W. C., The Quarternary geology of southeastern Wisconsin: U. S. Geol. Survey Prof. Paper 106, pl. II, 1918; Fidler, M. M., The preglacial Teays Valley in Indiana: Jour. Geology, vol. 51, pp. 411-18, 1943; Frye, J. C., Leonard, A. B., and Hibbard, C. W., Westward extension of the Kansas "Equus Beds": Jour. Geology, vol. 51, p. 46, 1943; Greene, F. C., Preliminary sketch of the history of the lower Missouri: Bull. Geol. Soc. America, vol. 32, pp. 83-86, 1921; Greene, F. C. and Trowbridge, P. M., Preglacial drainage pattern of northwest Missouri: Biennial Rept. State Geologist, Mo. Geol. Survey and Water Resources, Appen. VII, pp. 1-7, 1935; Horberg, Leland, A major buried valley in east-central Illinois and its regional relationships: Jour. Geology, vol. 53, pp. 349-59, 1945, Illinois Geol. Survey Rept. Inv. 106, 1945; Leverett, Frank, and Taylor, F. B., The Pleistocene of Indiana and Michigan and the history of the Great Lakes: U. S. Geol. Survey Mon. 53, pl. II, 1915; Reed, E. C., personal communication; Spencer, Origin of the basins of the Great Lakes of America: Am. Geologist, vol. 7, p. 87, 1891; Stout, Wilber, Ver Steeg, Karl, and Lamb, G. F., Geology of water in Ohio: Geol. Survey of Ohio, Fourth ser., Bull. 44, map No. 4, p. 51, 1943; Todd, J. E., The Pleistocene history of the Missouri River: Science, n. s., vol. 39, pp. 263-74, 1914.

[29]The restorations of glacial and interglacial streams shown in this series of maps are in large part hypothetical. They serve, however, to show the status of existing information and suggest problems for future investigation.

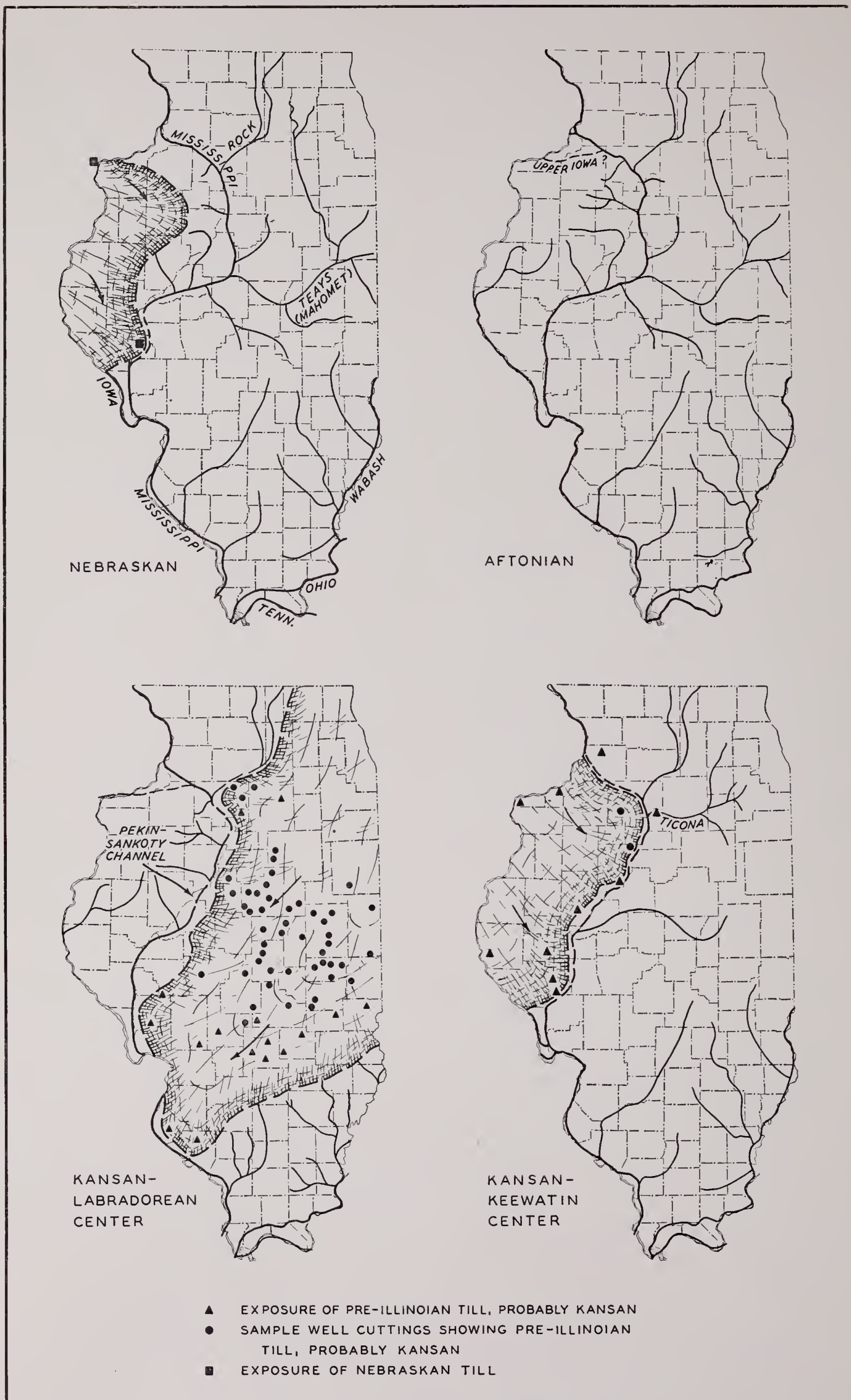
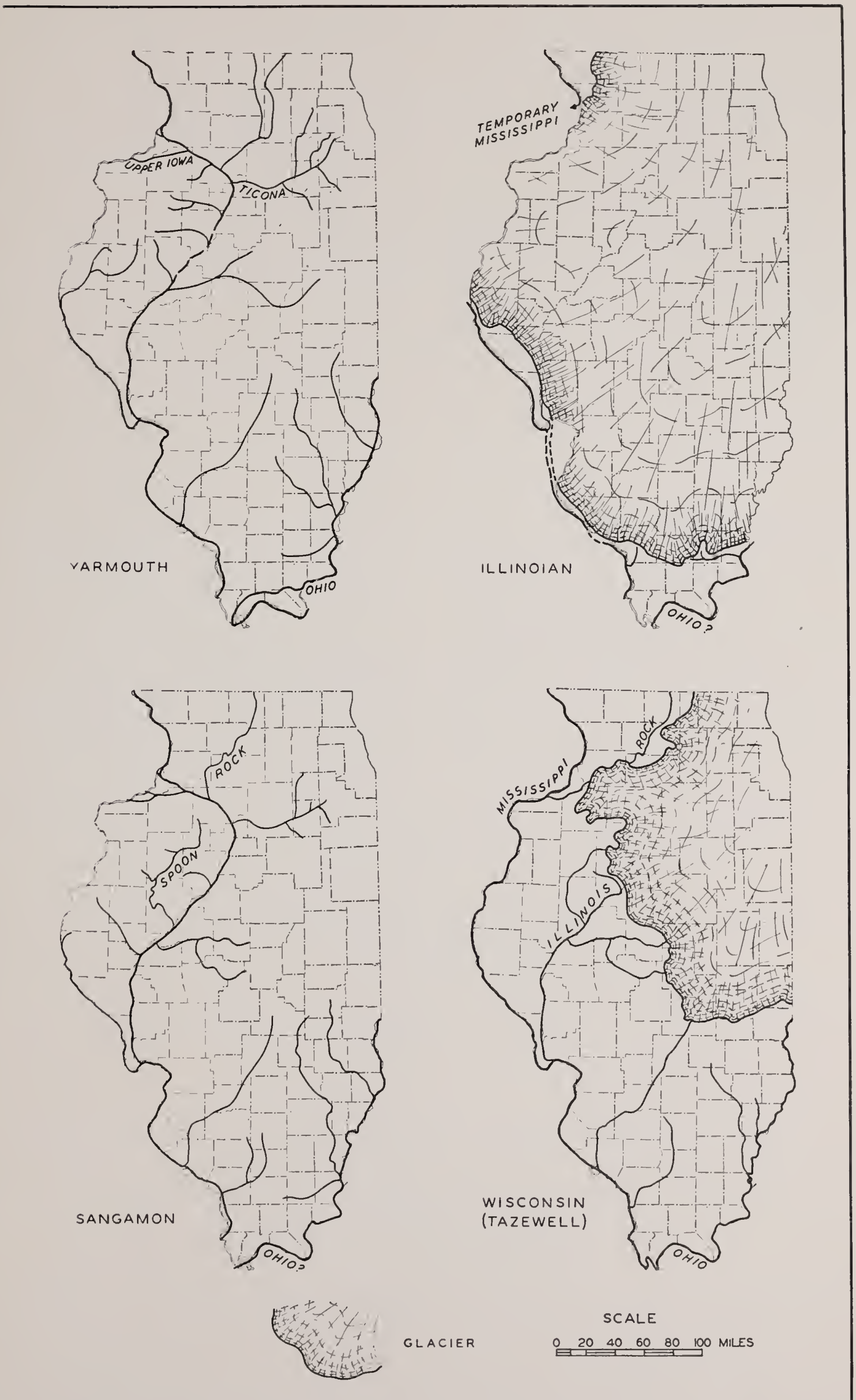


FIG. 21.—Drainage stages in Illinois during the glacial period. Based on studies Paul McClintock, F. T. Thwaites,



by A. H. Bell, G. E. Ekblaw, Leland Horberg, M. M. Leighton, Frank Leverett, H. B. Willman, and others.

Illinoian-Sangamon

With advance of the Illinoian glacier from the Labradorean center a maximum extent of the ice in Illinois was attained and all but the three driftless areas were ice-covered. During glaciation the Mississippi was pushed westward into a temporary course through glacial Lake Calvin in Iowa, but with retreat of the ice the former course through Princeton Valley was probably resumed. Ancient Rock River, however, was permanently diverted into its present course south of Rockford and the preglacial valley and its important tributary, Troy Valley, were abandoned. In the Peoria region the northern part of the Pekin-Sankoty Valley was buried and the present valley at Peoria established.

Important changes probably also occurred in the Pennsylvanian Upland of western Illinois: (1) The upper portions of Spoon River were diverted from their eastward and northward courses into the present valley; (2) Carthage Valley was completely buried and abandoned; (3) numerous small valleys were buried; and (4) low bedrock cols were eroded or re-excavated across the preglacial divide at several points.

In southern Illinois the glacio-fluvial deposits of Illinoian and Wisconsin age have not been differentiated in most places, but it is likely that much of the fill in the Kaskaskia, Muddy, and Wabash basins was deposited at this time. No important drainage modifications are known to have occurred during the Sangamon interglacial stage.

Wisconsin-Recent

Although drainage history during the final Wisconsin stage is known in detail in many areas, only two events involving the major drainage systems will be noted: (1) The Mississippi was probably diverted from its ancient course through Illinois Valley to its present channel; and (2) Ticona Valley was buried, and the present Upper Illinois River was established. With retreat of the Wisconsin ice a new generation of consequent streams developed on the newly formed till-plains. Most of these are independent of the bedrock valleys which lie deeply buried below the surface.

CHAPTER 6—GROUNDWATER RESOURCES OF THE MAJOR BEDROCK VALLEYS

GENERAL GROUNDWATER CONDITIONS

Occurrence of Groundwater

Throughout most of Illinois all the openings in the glacial deposits and underlying bedrock below a depth of a few feet are filled with water. The upper surface of this *zone of saturation* is referred to as the *water-table* (fig. 22). The depth to the water-table varies from place to place, depending on the surface topography; it rises under hills and intersects the ground surface along valleys at the level of permanent streams, springs, and swamps; its position fluctuates from season to season and year to year, depending upon variations in precipitation.

Within the zone of saturation the water directly below the water-table is *unconfined* and moves freely under the control of the slope of the water-table. Many shallow drift wells (A, fig. 22) obtain water from this zone, and their water levels indicate the position of the water-table. In other drift wells, as well as most bedrock wells, the water obtained is *confined* between impervious layers of clay or shale under artesian pressure and is hydraulically independent of the water above (B, C, fig. 22). In these wells the water level may be either above or below the water-table and is controlled by the difference in head between points of intake and discharge, the amount of frictional resistance developed during movement, and the amount of withdrawal. Broadly speaking all wells of this type are *artesian wells.*

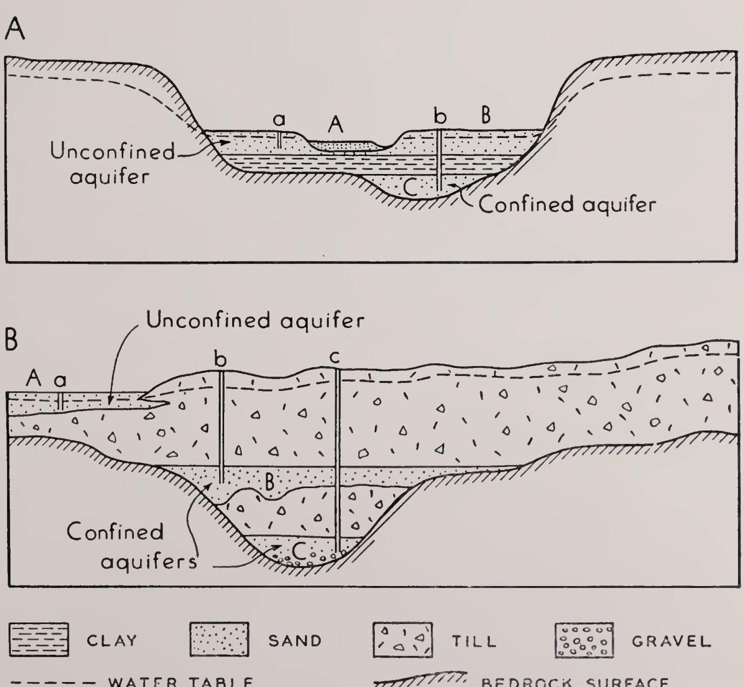


Fig. 22.—Types of glacial aquifers.

Source and Movement of Groundwater

Essentially all of the water obtained in wells is derived from rain and melted snow which sinks into the ground and is drawn by gravity to the zone of saturation. The unconfined water just below the water-table is derived chiefly from moisture which fell during previous months and is subject to seasonal and annual fluctuations in precipitation. The confined water in the artesian aquifers, however, is received from moisture which fell much longer ago, generally in remote areas, and is unaffected by recent variations in precipitation.

The movement of groundwater depends mainly upon the size of the smallest interconnecting openings in the deposit and upon pressure differences from point to point. It is the latter that determines the direction of movement. In the case of unconfined water the direction of movement is down the slope of the water-table toward points of discharge along streams and toward wells that are being pumped. The rate at which water moves through an aquifer is a measure of its *permeability* and is determined by the size, character, and continuity of the openings. The amount of water within a deposit is controlled by the total pore space present, or the *porosity*. Artesian waters move down the dip of the confined aquifer which, in the case of valley-fills, is ordinarily downstream.

GROUNDWATER IN BEDROCK VALLEY DEPOSITS

Relation of Glacial Aquifers to Bedrock Valleys

The prevalence of continuous sand and gravel deposits of important thickness within bedrock valleys rather than on bedrock uplands has been shown by numerous groundwater studies in the State and is indicated by all the subsurface data available.

The fundamental reason for this relation is found in the conditions under which glacial outwash was deposited. As the ice advanced across the preglacial landsurface, meltwaters were concentrated along the larger valleys where they deposited valley-trains of sand and gravel. These deposits extended for miles down-stream from the ice fronts, their thickness and composition varying with proximity of the ice and glacial drainage conditions. In some places the deposits were over-ridden by the ice and buried by till; in others the valleys were left open. During later stages of glaciation, younger valley-trains were added to the older fill in valleys which had remained open or had been re-excavated during the intervening interglacial stage. In places where valleys were largely buried by till it appears that sags often were left over the buried valleys and these were sites of deposition of younger outwash. This seems to have been true of the Illinoian sand in Mahomet Valley.

Aside from the statistical advantage of encountering sand and gravel where the drift is thickest above bedrock valleys, there remains one other important reason why the deposits are more common within the valleys than above the bedrock uplands; initial concentrations of outwash within the valleys are more likely to be preserved from later glacial erosion than the upland deposits which could readily be swept away and incorporated in younger drift.

Types of Aquifers

The aquifers in the bedrock valleys can be classed on the basis of their geologic relations as follows:

A. Recent alluvial deposits—Mississippi and Illinois Valley (A, fig. 22A).

B. Surficial outwash.
   1. Outwash plains — Green River Lowland, Havana Lowland (A, fig. 22B).
   2. Valley-trains; occur below recent alluvium or as terraces—Mississippi, Illinois, Wabash, Cache and other large valleys (B and C, fig. 22A).

C. Buried outwash; occurs directly on bedrock below glacial till or between till-sheets — Mahomet, Mackinaw, Princeton, Ticona, Shabonna, Troy and other buried valleys (B and C, fig. 22B).

D. Buried interglacial alluvial deposits —Mahomet and probably other valleys; usually unimportant aquifers.

Of these types the outwash deposits (B and C) are most important because of their continuity and permeability. It is to be emphasized, however, that there are important variations in the character of all deposits, both vertically and horizontally, within short distances. In this respect the glacial aquifers are much more uncertain as a source of supply at a given location than are the important bedrock aquifers in the northern third of the State.

Wells in recent alluvial deposits and surficial outwash usually encounter unconfined water so that water levels are high and rise to the level of the water-table (a, fig. 22A and B). In the case of deeper deposits within present valleys (C, fig. 22A) and the buried deposits (B and C, fig. 22B) where confined water is obtained, water levels are independent of the water-table and usually lower than in water-table wells. Most of the important supplies of water in the State are confined.

FAVORABLE AREAS

The areas in which conditions are favorable for the development of important groundwater supplies are shown in figure 23. The map is based on records of wells and borings, many of which are shown, and upon the known and inferred positions of water-bearing deposits within the larger bedrock valleys. It is believed that the areas shown include the most important glacial aquifers within the State.

The following discussion indicates only the general geological relations of these aquifers. Descriptions of local conditions are outside the scope of the present report and may be obtained from publications dealing with specific areas[1] or by communicating directly with the State Geological Survey. As available information on the stratigraphy of the deposits was summarized in Chapter 2, this discussion is confined largely to the possibilities of obtaining groundwater.

In most areas shown in figure 23 the available data are inadequate to assure supplies at specific locations. For this reason, and because of the sudden lateral variations in the permeability of most glacial deposits, electrical earth-resistivity surveys and test-borings are usually required in order to discover the most favorable locations within an area. In short, the map is intended to indicate general areas where conditions are especially favorable for securing supplies rather than exact points where supplies are obtainable.

Bedrock Valleys Entering the Lake Michigan Basin

These valleys are situated in an area where supplies are obtained almost exclusively from shallow "limestone" wells in the Niagaran dolomite or from deeper artesian aquifers so that very little information is available on the potentialities of the glacial deposits. There are only a few places where pre-Wisconsin drift has been recognized within the valleys, which suggests that the Wisconsin ice may have scoured out much of the earlier fill. Because of this and the absence of large major valleys draining away from the ice fronts, the area is not considered as promising as regions to the south.

It is known, however, that important glacial aquifers are locally present, especially in Lake County, although they are largely undeveloped because of the general practice of constructing rock wells. In a number of places studies of rock wells have revealed that large amounts of water from overlying glacial aquifers enter the well because of faulty casing; in other places the presence of sand and gravel is indicated by drillers' records. In many places these deposits appear to be unrelated to the bedrock valley system.

One of the best known glacial aquifers restricted to a bedrock valley occurs along Hadley Valley northeast of Joliet.[2] In a

[1]Leverett, Frank, The Illinois glacial lobe: U. S. Geol. Survey, Mon. 38, Chap. XIV, pp. 550-797, 1899, and Habermeyer, G. C., Public ground-water supplies in Illinois: Illinois State Water Survey Bull. 21, p. 710, 1921; Supplement I, pp. 711-1090, 1938, Supplement II, pp. 1091-1135 provide much detailed information on specific localities throughout the State. Most of the studies dealing with local areas are listed on pp. 12, 13.

[2]Horberg, Leland and Emery, K. O., Buried bedrock valleys east of Joliet and their relation to water supply: Illinois Geol. Survey, Circular 95, 6 pp., 1943.

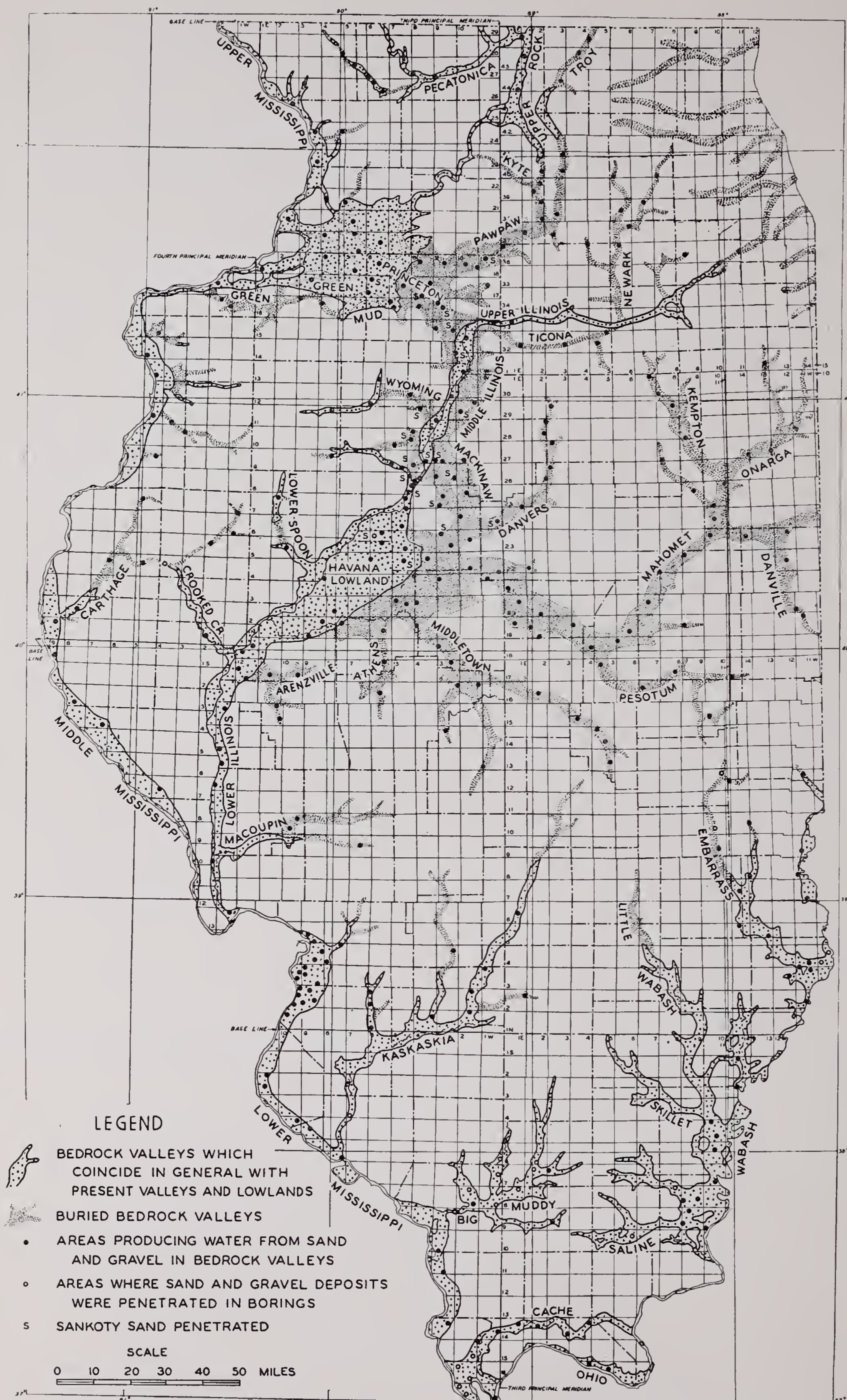


FIG. 23.—Distribution of the actual and potential aquifers of the major bedrock valleys.

recent test-hole in this deposit (sec. 27, T. 36 N., R. 11 E.), 108 feet of sand and gravel were penetrated.

Upper Mississippi Valley

The deposits in the Upper Mississippi Valley (fig. 23) range in thickness from about 140 feet to possibly 340 feet, the average being well over 150 feet (table 2). All of the records available indicate that the fill is composed largely of sand with subordinate amounts of gravel. Study of sample cuttings shows that a well in sec. 19, T. 26 N., R. 2 E., Jo Daviess County, penetrated 170 feet of clean sand and gravel. Farther south a well in sec. 34, T. 21 N., R. 2 E., Rock Island County, is reported to have penetrated 194 feet of "clean sand." Many private water supplies along the valley are obtained from well points driven into shallow sands and from dug wells which extend just below the water-table, but there are no wells known which produce important amounts from the deeper part of the fill. This area unquestionably represents one of the largest undeveloped groundwater pools within the State.

Glacial aquifers of less importance appear to be present in lower parts of larger tributary valleys. Cattail Channel and the valley of Johnson Creek in Carroll County are probably the most promising (pls. 1 and 2).

Princeton Bedrock Valley

Groundwater aquifers within Princeton bedrock valley and its numerous tributaries are of two general types: (1) The surficial outwash and underlying deposits within the Green River Lowland; and (2) the deeper deposits buried by till outside this area (fig. 23).

In the Green River Lowland the glacial drift has a maximum thickness of more than 200 feet, the upper part of which is composed of Wisconsin sand and gravel. Water supplies within the area are secured almost exclusively from driven well points and dug wells in shallow sands so that there is scant information on the lower part of the drift. There is evidence, however, that a thick body of sand is present at least locally because one of the few deep wells in the area in sec. 8, T. 17 N., R. 6 E., Bureau County, penetrated 132 feet of Sankoty sand[3] similar to the deposits which are so productive in the Peoria region. Sankoty sand is also present at Prophetstown in southern Whiteside County and possibly at Geneseo in northern Henry County.

Outside the Green River Lowland most supplies are obtained from confined glacial aquifers which appear to vary considerably in thickness and composition. Thick deposits of sand, including some Sankoty sand, as shown by the log on p. 5, are known to be present in the eastern part of the valley. In tributary valleys geologic conditions appear to be most favorable along buried sections of Green River and Mud Creek bedrock valleys.

Adequate glacial aquifers are present at most places within the area, and probably large undeveloped reserves are present, especially in the Green River Lowland.

Middle Illinois Bedrock Valley

The deposits along the present Middle Illinois Valley have a maximum thickness of about 200 feet and are composed largely of sand and gravel. Both Wisconsin sand and Sankoty sand appear to be present and in places are separated by till.[4] The fill in the buried portions of the bedrock valley (fig. 23) consists of thick Wisconsin till overlying Illinoian till and Sankoty sand and gravel. Sankoty sand has been recognized in numerous wells throughout the length of the valley and appears to be a continuous deposit (fig. 23).

Favorable groundwater conditions exist throughout the area, and important aquifers similiar to those which produce large amounts of water in the Peoria region are doubtless present at most places.

Bedrock Valleys in the Peoria Region

The Peoria region ranks as one of the two largest producing glacial aquifers in

[3]The log is given on p. 51.
[4]See log of John A. Fitschen well, p. 56.

the State, and the entire municipal and industrial supply is obtained from this source. The Illinois State Water Survey estimates "that the average daily pumpage based on figures for the year 1944 was 90 million gallons for the Peoria, East Peoria, and Pekin area."[5] Present supplies are obtained largely from: (1) The Sankoty well field located near the junction of the Pekin-Sankoty and ancient Mississippi valleys at the north edge of Peoria; (2) wells along the present narrow valley of Illinois River at Peoria; and (3) wells along the south part of the Pekin-Sankoty Valley extending from West Peoria south to Pekin. Water is obtained from the following deposits, in order of increasing importance: recent alluvium, Wisconsin outwash, and Sankoty sand.[6]

Although the area has been intensively developed, it appears from geological and electrical earth-resistivity studies[7] that addiional supplies may be obtained from the Pekin-Sankoty Valley and from the ancient Mississippi channel north and east of the city.

Mackinaw Bedrock Valley

As indicated by the section on page 60, three potential aquifers are present in the fill of buried Mackinaw Valley: (1) A discontinuous sand 10 to 20 feet thick at the base of the Wisconsin till; (2) a somewhat more persistent Illinoian sand, 20 to 30 feet thick; and (3) the pre-Kansan Sankoty sand which is 50 to more than 100 feet thick and appears to be continuous along the deeper part of the valley.

All of the wells within the area obtain water from these deposits, but there have been no attempts to develop large supplies, and the productivity of the aquifers at favorable localities is not known. Static water levels in the deeper sands are generally low and the sands are often reported to be "fine" or "dirty." The records suggest that gravel and clean sand are not as widespread as along other sections of the ancient Mississippi channel. However, the important lower Sankoty sand has not been adequately prospected and in many areas may become a highly productive aquifer.

[5]Personal communication.
[6]See pp. 59-62 for description of valleys and these deposits.
[7]Emery, K. O., Electrical earth-resistivity survey at Peoria and vicinity: Illinois Geol. Survey, unpublished manuscript, 1941.

Upper Rock River Valley and Pecatonica Valley

The upper Rock River and Pecatonica bedrock valleys include that part of the preglacial valley system which lies north of the Bloomington moraine and is followed by present drainage (fig. 23). The deposits which partially fill the old valley extend to a maximum depth of about 250 feet below the level of Rock River and are composed largely of sand and gravel with thin beds of silt and clay. The record of the Milaeger-Woodward well, based on a study of sample well cuttings, indicates the general character of the deposits in the valley at Rockford.

Milaeger Drilling Company—Woodward Governor Company Well No. 2, SW. 1/4, NW. 1/4, sec. 7, T. 44 N., R. 2 E., Winnebago County. Elevation 718 A.T.

	Thickness Ft.	*Depth Ft.*
Pleistocene system		
Sand and silt	35	35
Sand, coarse, clean	10	45
Clay and silt	20	65
Sand, medium, some gravel	35	100
Gravel, clean	10	110
Sand, medium, silty	25	135
Sand, coarse, some gravel	30	165
Gravel, mainly clean, some silt	20	185
Sand, coarse, some gravel	15	200
Gravel, clean	30	230
Sand, coarse, some gravel, dirty	10	240
Ordovician system		
St. Peter sandstone		

The valley deposits are situated in an area where large amounts of water are readily obtained from bedrock formations so that the glacial aquifers are developed almost entirely in private farm wells. The groundwater reserves in the valley deposits both at Rockford and probably to the north, where the fill is not as well known, are large and for the most part undeveloped.

Deposits reaching a maximum thickness of more than 250 feet are present in Pecatonica bedrock valley, but a large part of the deposit consists of silt and fine sand incapable of producing large quantities of water. Gravel and clean sand are known in some places and may be important locally.

Pawpaw and Troy Bedrock Valleys

The Pawpaw and Troy bedrock valleys in most places are deeply buried by Wisconsin and older drift which has a maximum thickness of over 600 feet. Sand and gravel aquifers are present at various horizons, but appear to be thickest and most continuous in the pre-Wisconsin drift.[8] Private water supplies along the valleys are obtained largely from these deposits, but there are no areas of heavy withdrawal.

The groundwater possibilities along the two valleys are probably not as important as those along many other major valleys because thick till deposits are known to be present in many places. However, the present data are incomplete, and large continuous aquifers in the lower portion of the valley-fills may later be recognized. This possibility is suggested by a well in Pawpaw Valley in northeastern Lee County (sec. 11, T. 39 N., R. 2 E.) in which 195 feet of sand is reported to have been penetrated.

Ticona Bedrock Valley

Sand and gravel deposits in places more than 100 feet thick are known to occur within the Ticona bedrock valley. The deposits are of pre-Wisconsin age and are probably restricted to the deep portion of the valley. The deposits at favorable localities could probably furnish large quantities of water and are undeveloped except in small private wells and by the village wells at Grand Ridge.

Mahomet Bedrock Valley

Two important and continuous aquifers occur along Mahomet Valley: (1) A middle Illinoian sand which extends over wide areas beyond the valley boundaries shown in figure 23 below elevations of 600 to 660 feet; and (2) a pre-upper Kansan sand which is largely confined to the deeper portion of the valley. The stratigraphic relations of the deposits are shown by figure 13.

The Illinoian aquifer is widely developed above Piatt County in the eastern part of the area. It has a thickness of 10 to 90 feet at Champaign-Urbana, 50 feet at Rantoul, 18 to 50 feet at Paxton, and 25 to 80 feet at Hoopeston. The deposit as a whole varies considerably in permeability both laterally and vertically within short distances. The most permeable facies consists of clean coarse gravels; the less permeable facies is composed of silt and fine sand. The deposit is present in Danville and Pesotum tributary valleys and may extend northward for a short distance into Kempton and Onarga valleys.

The Kansan sand and gravel occurs below elevations of 550 to 500 feet along the deep part of the valley at least as far east and northeast as the northern boundary of Champaign County and probably for many miles beyond. The deposit has a thickness of about 200 feet at Clinton, 150 feet at Monticello, and 160 feet at Mahomet.

The area as a whole is underdeveloped, and large supplies are obtainable at many localities. At present the heaviest withdrawals are in the Champaign-Urbana area where the important aquifer is the Illinoian sand. "The Illinois State Water Survey estimates that the average daily pumpage based on figures for the year 1944 was 5 million gallons for the Champaign-Urbana area."[9]

Lower Illinois Valley

Two sections of the lower Illinois bedrock valley are recognized: (1) The broad upper valley within the Havana bedrock lowland; and (2) the narrow lower valley below Beardstown (see pp. 72, 73). In both sections the glacial deposits have an average thickness of about 150 feet and are composed of about 50 feet of silty sand underlain by sand and gravel (cross-section C-C, fig. 13). Most of the wells in the area are shallow water-table wells in the surficial outwash, and there are no important withdrawals from deeper aquifers. Conditions are favorable for obtaining large supplies at almost any location within the valley.

Sand and gravel deposits are known to be present in the major tributaries (fig. 23)

[8]See log on page 65.

[9]Personal communication.

Thorpe Concrete Well Company—Swift and Company Well No. 2, sec. 2, T. 2 N., R. 10 W., St. Clair County. Elevation 413 feet A.T.

	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Pleistocene system				
Soil, sandy	18		18	
Sand, fine	7		25	
Clay, blue	2		27	
Sand, fine, red	5		32	
Clay, blue	3		35	
Sand, gritty, red	15		50	
Sand, fine	16		66	
Sand, coarse	7		73	
Sand and gravel, cemented	0	8	73	8
Sand, coarse, gravelly	6	4	80	
Sand, building, some coarse	15		95	
Sand and gravel	8		103	
Boulders, cemented	5		108	
Mississippian system				
Rock	1	6	109	6

which include Middletown, Athens, Arenzville, and Macoupin Creek bedrock valleys on the east and Spoon River and Crooked Creek bedrock valleys on the west (see pp. 73, 74). The deposits occur in association with till and are not as thick or continuous as the deposits in the main valley.

Middle Mississippi (Ancient Iowa) System

The deposits in the Middle Mississippi bedrock valley, like those in the Lower Illinois Valley, have an average thickness of about 150 feet and are composed largely of sand and gravel. There are no important withdrawals from these aquifers and they appear to be continuous except along the lower rapids in northwestern Hancock County. Along buried Carthage Valley (fig. 23), the largest tributary, sand and gravel deposits more than 50 feet thick occur in the southwestern part of the valley below Carthage and near the Hancock-McDonough County line. In other places glacial till is the dominant component.

Lower Mississippi Valley

The fill in the Lower Mississippi bedrock valley ranges in thickness from about 125 to 170 feet and is composed largely of sand and gravel with minor amounts of silt and clay. In the East St. Louis district[10] these deposits form one of the two largest producing glacial aquifers in the State. "The Illinois State Water Survey estimates that the average daily pumpage based on figures for the year 1944 was 90 million gallons for the East St. Louis region, from the bottom lands in the vicinity of East St. Louis extending from Alton to Dupo."[11] A driller's record of the deposits in this area is given above.

Outside the East St. Louis district there are no important withdrawals from the deeper part of the fill so that the entire valley, except for the narrows in Alexander County, has large undeveloped reserves.

Kaskaskia and Big Muddy Drainage Basins

Water-laid deposits in the Kaskaskia and Big Muddy bedrock valleys reach thicknesses of more than 100 feet and are composed of sand, silt, and clay, with minor amounts of gravel. In general these sediments have low permeabilities and are not first-class aquifers. The valleys, however, lie in a region where groundwater conditions are very unfavorable and for this reason are significant as possible sources of supply. There appear to be no large continuous aquifers, but detailed prospecting may show that important gravel beds are present locally.

Wabash Drainage Basin

Included in the Wabash area are the deposits along the main bedrock valley and its larger tributaries which are, from north to south, the Embarrass, Bonpas, Little Wabash, and Saline bedrock valleys.

The deposits along the main valley are 100 to 150 feet thick and consist of sand, gravel, silts, and clay in about that order of abundance. The general character of the sequence in Lawrence County is shown by the study of sample well cuttings from the Lawrenceville School test No. 5.

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[10]Bowman, Isaiah, and Reeds, C. A., Water resources of the East St. Louis district: Illinois Geol. Survey Bull. 5, pp. 1-128, 1907.

[11]Personal communication.

Lawrenceville Advanced Twin Engine School Test Well No. 5, sec. 27, T. 4 N., R. 11 W., Lawrence County. Elevation 418 A.T.

	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Pleistocene system				
No samples	12	3	12	3
Gravel, sandy	4	6	16	9
Gravel, clean	3	3	20	
Sand and gravel, clean	30		50	
Sand, clean	5		55	
Gravel, clean	5		60	
Sand, slightly silty, coarse	10		70	
Gravel, sandy, dirty	5		75	
Sand, fine, clean	1	6	76	6

Large quantities of groundwater are probably obtainable at most points along the deeper part of the valley, and there are no important withdrawals from the Illinois side of the valley.

The deposits in the tributary valleys are similar to those in the Kaskaskia and Big Muddy drainage basins and involve similar problems. The buried portion of the preglacial Embarrass is an exception and in places may contain important thicknesses of sand and gravel.

Cache Valley

The deposits in this abandoned bedrock valley of the Ohio River range in thickness from 140 to 180 feet and are composed largely of sand and gravel. A record based on the study of sample well cuttings and showing the character of the fill in northern Pulaski County is given in the log of the Hayes and Sims—Chicago and Eastern Illinois Railroad test hole.

Hayes and Sims—Chicago and Eastern Illinois Railroad test hole, sec. 10, T. 14 S., R. 1 E. Pulaski County. Elevation 340 feet A.T.

	Thickness Ft.	Depth Ft.
Pleistocene system		
Silt and sand, clayey	20	20
Sand and granular gravel, dirty	25	45
Sand, clean	15	60
Sand, clean, contains wood fragments	5	65
Sand, clean	5	70
Sand and granular gravel	25	95
Sand, medium to very coarse	10	105
Granular gravel, clean	10	115
Sand, fine to coarse, dirty	15	130

The groundwater resources of the valley apparently are very large and essentially undeveloped.

SUMMARY

It is concluded: (1) That large underdeveloped groundwater resources occur within the glacial deposits filling major bedrock valleys throughout the State; (2) that the thickest and most continuous aquifers are within the present Mississippi, Illinois, and Wabash valleys which in large part coincide with preglacial valleys; (3) that important aquifers are also present along large buried valleys, such as Mahomet, Princeton, Shabbona, Troy, Ticona, and Carthage bedrock valleys; and (4) that although glacial aquifers are commonly present in the drift outside the bedrock valleys, especially within the Wisconsin drift-sheet, the most favorable conditions are usually present along these valleys.